Practical Parasitology

Sana'a University

D. Ameera Al-Qadasi

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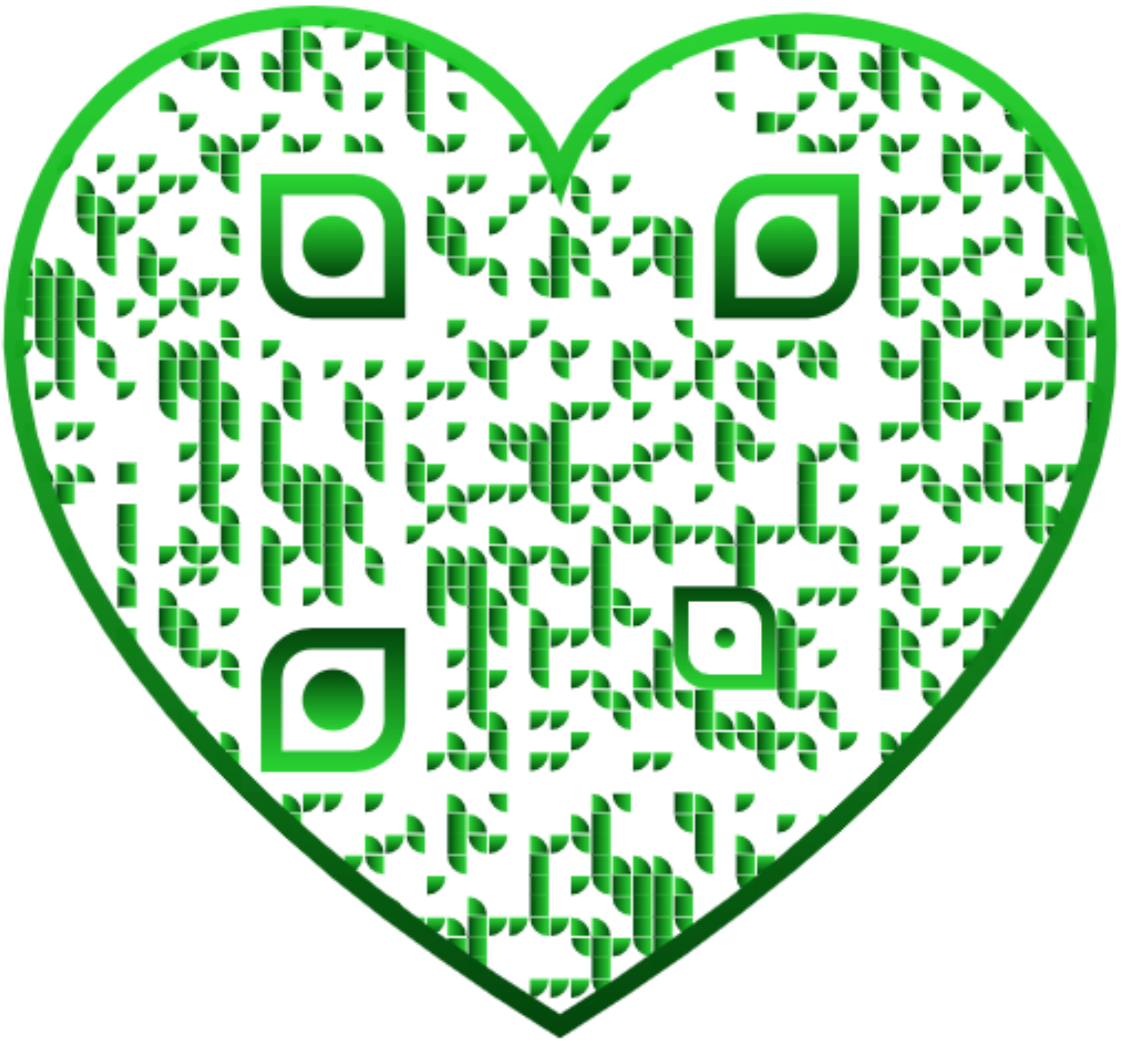

Practical Parasitology

❑ Parasitology

It is the study of parasites, their hosts, and the relationship between them.

- **Parasite**

A living organism which gets nourishment from another living organism where it lives is called parasite. They may be:

1. **Ectoparasite:** living on the surface of other organisms e.g. lice, ticks, mites, etc.
2. **Endoparasite:** live inside the body of other organisms, e.g. *Entamoeba histolytica*, *Ascaris lumbricoides*, etc.

❑ Parasitism

A form of symbiosis in which one organism (called parasite) benefits at the expense of another organism usually of different species(called host).

- **Host**

An organism which harbors the parasite. Host may be of following types:

1. **Definitive host:** when it harbors parasite in adult form or when parasite utilizes sexual method of reproduction.
2. **Intermediate host:** harbor's larval stages of parasite.
3. **Reservoir host:** which make parasite available for transmission to other hosts.

- **Vector**

- A vector is any agent (person, animal or microorganism) that carries and transmits an infectious pathogen into another living organism.

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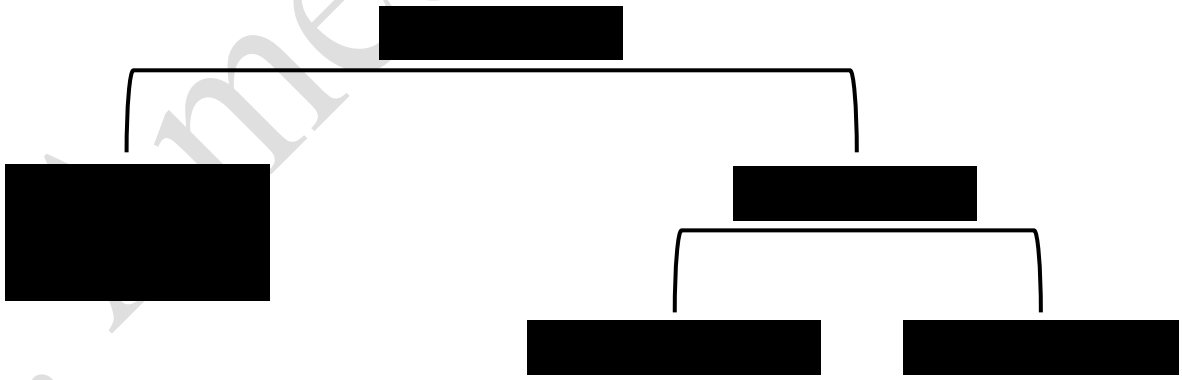
- Arthropods form a major group of disease vectors with mosquitoes, flies, sand flies, lice, fleas, ticks and mites transmitting a huge number of diseases.
- Many such vectors are haematophagous, which feed on blood at some or all stages of their lives. When the insects blood feed, the parasite enters the blood stream of the host. This can happen in different ways.
    - **Examples of vectors:**
        1. The *Anopheles* mosquito, a vector for Malaria.
        2. Pool feeders such as the sand fly and black fly, vectors for Leishmaniasis and Onchocerciasis respectively.

- **Source of infection**
    1. Ingestion.
    2. Arthropod bites.
    3. Penetration of intact skin or mucous membranes.
    4. Sexually.

- **Taxonomy and classification:**

  The classification of parasites according to number of cells:



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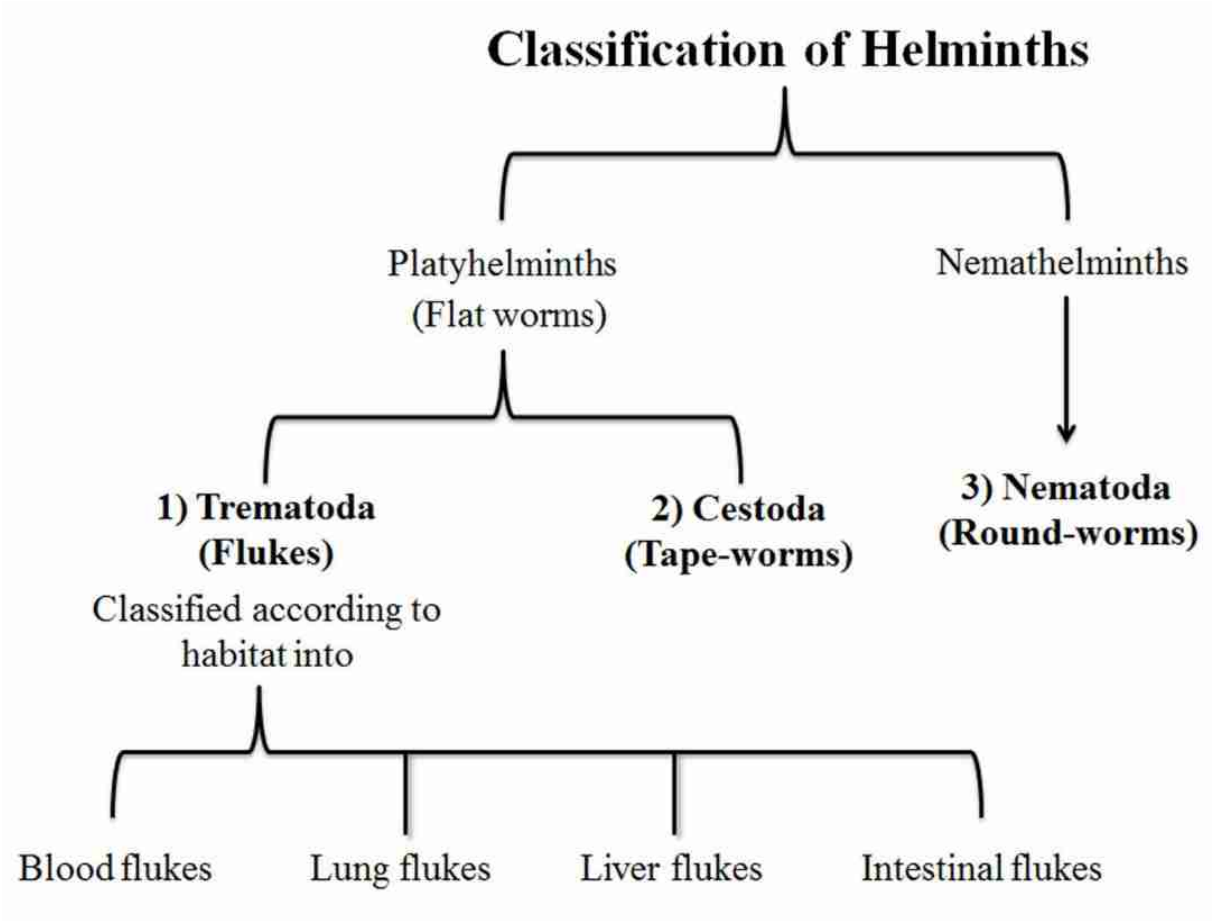
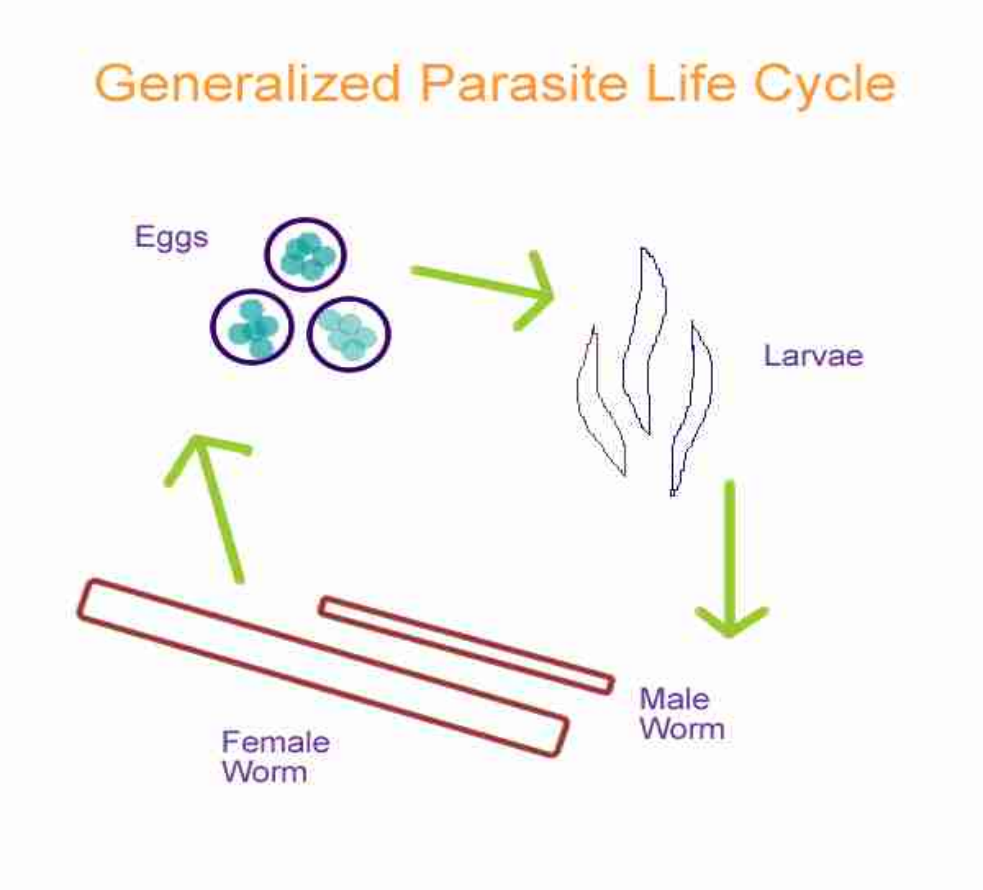
- **Classification of Hehminths:**



- **Characteristics of Helminths:**
  - Helminths are macroscopic, multicellular, eukaryotic worms.
  - They have well developed organ systems.
  - Life cycles are complex.
  - Intermediate hosts are often needed to support larval stages.
  - Intermediate host-which harbor asexual phase of parasite.
  - Definitive host-which harbor sexual phase of parasite.
  - Adult worms are either dioecious or monoecious.
  - Distribution is Worldwide.
  - An infection by a Helminth is known as helminthiasis, soil-transmitted helminthiasis, helminth infection or intestinal worm infection

- There are three groups of helminthes:
    - Cestodes (tapeworm).
    - Trematodes (fluke).
    - Nematodes (roundworm).

- **Overview of Generic Life Cycle**



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1. Trematodes

- **General characters of trematoda**

1. Leaf–like worms ,flattened dorsoventrally (except Schistosoma female).
2. With 2 or 3 suckers (oral, genital and ventral suckers).
3. Attach to host tissues via a ventral sucker to obtain nutrients.
4. They do not contain body cavity
5. Lack complete digestive tract
6. Geographical distribution limited because the intermediate host is limited.
7. A snail is generally intermediate hosts.
8. Grouped according to the site in the body they parasitize.
9. All trematode parasites are monoecious (hermaphrodite) except *Schistosoma* spp.

- **Classification of Trematodes according to habitat inside the human:**

1. **Liver (Hepatica) flukes:**
   - *Fasciola hepatica*
   - *Fasciola gigantica*
2. **Blood flukes:**
   - *Schistosoma haematobium*
   - *Schistosoma mansoni*
   - *Schistosoma japonicum*
3. **Intestinal flukes:**
   - *Heterophyes heterophyes*
4. **Lung flukes:**
   - *Paragonimus westermani*

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1. Liver (Hepatica) flukes

- ***Fasciola hepatica***
- ***Fasciola gigantica***

- **Scientific Classification**

  - Kingdom: Animal
  - Phylum: Platyhelminthes
  - Class: Trematoda
  - Genus: *Fasciola*
  - Species: *F. hepatica* and *F. gigantica*

Adult stage of *Fasciola* spp.:

Name	***Fasciola hepatica***	***Fasciola gigantica***
Definition	Sheep	Cattle liver flukes
Size	3 x 1 cm	6 x 1.5 cm
Lateral margins	Converging	Parallel
Suckers	Equal	Oral smaller than ventral
Shoulders	More prominent	Less prominent
Distribution	Latin America, Africa , Europe & China	Egypt , Africa & Far East
Disease	Fasciolasis (liver rot)	

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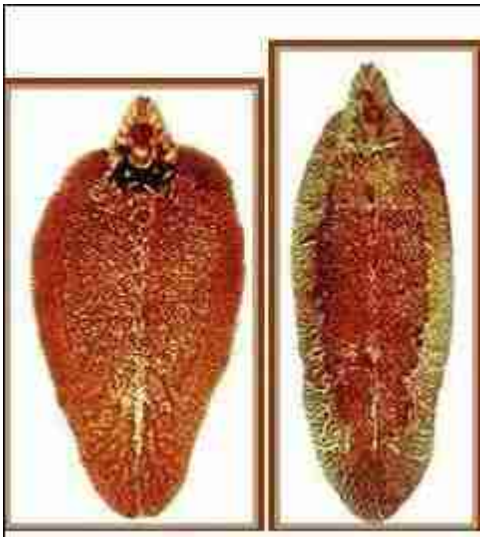
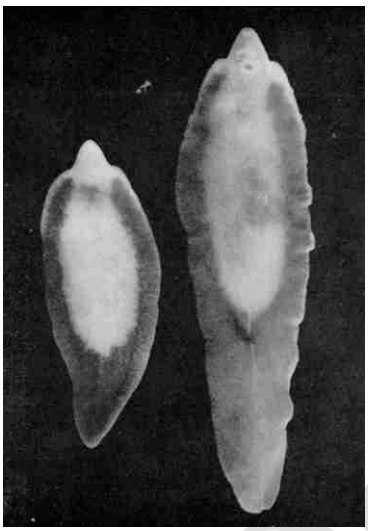
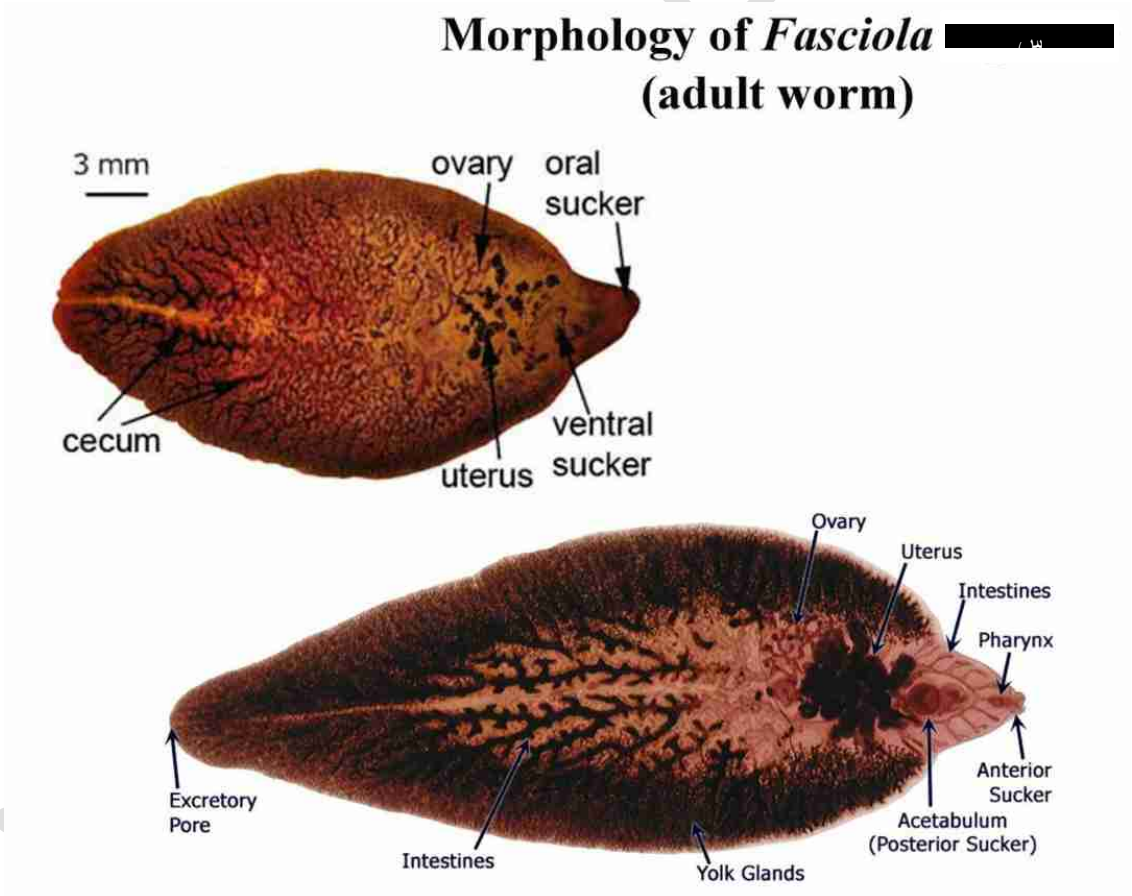




Living specimens are a grayish-brown in color



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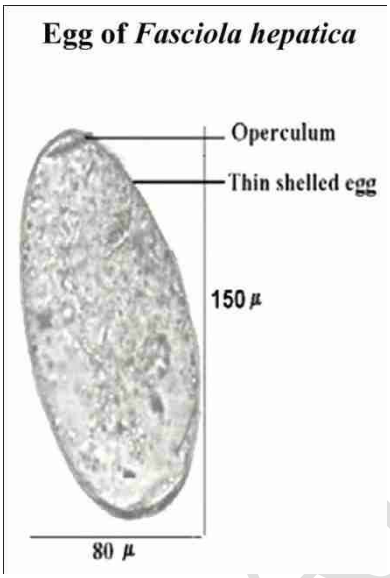
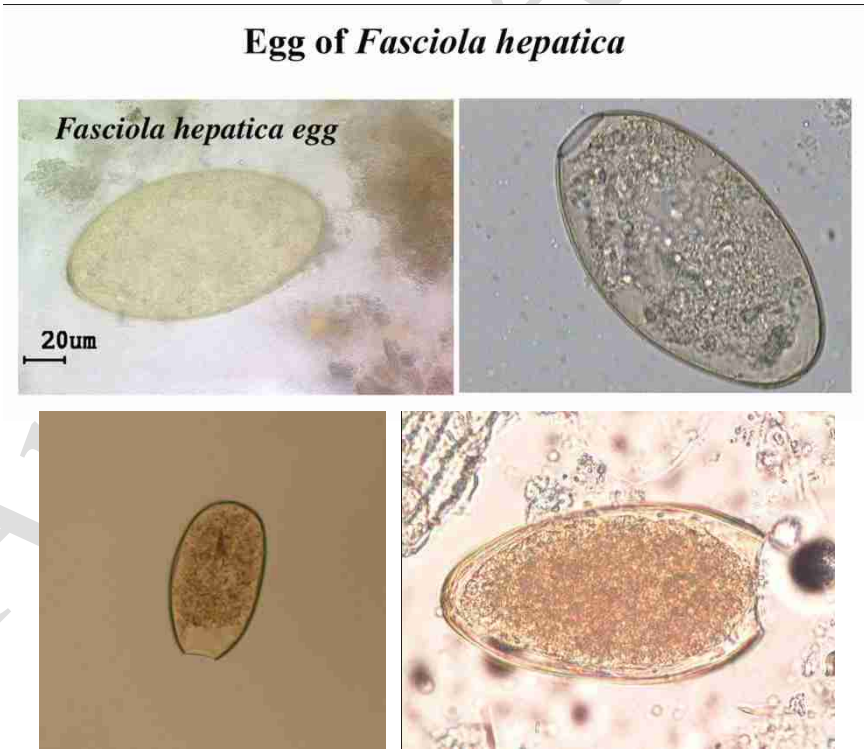
- **Egg of Fasciola species:**
  - Size:140x70 µm.
  - Shape: oval, operculated and thin shelled.
  - Color: yellowish brown in color
  - Content :immature ovum





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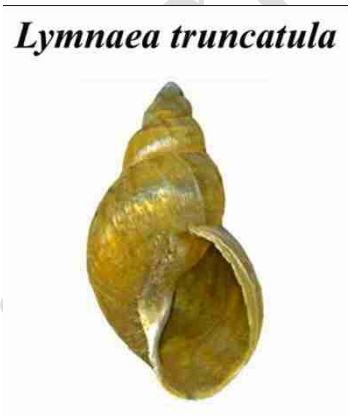
- **Diagnostic Stage**

➢ Egg
- The largest egg in trematodes.
- Operculated containing immature miracidium.
- Eggs hatches in fresh water after 2-3 weeks.

	Fasciola hepatica	***Fasciola gigantica***
Habitat	Adult lives in bile duct and liver	
Definitive host	Human (Human is an accidentally definitive host)	
Intermediate host	Snail *Lymnaea trunculata*	Snail *Lymnaea cailliaudi*
Reservoir host	Sheep	Cattle
Diagnostic Stage	Eggs in stool (Large operculated eggs with immature miracidium)	
Infective Stage	Encysted metacercaria on blades of aquatic plants or fresh water contaminated with encysted metacercaria	
Mode of infection	Eating raw aquatic plants with encysted metacercaria or eating raw sheep liver	



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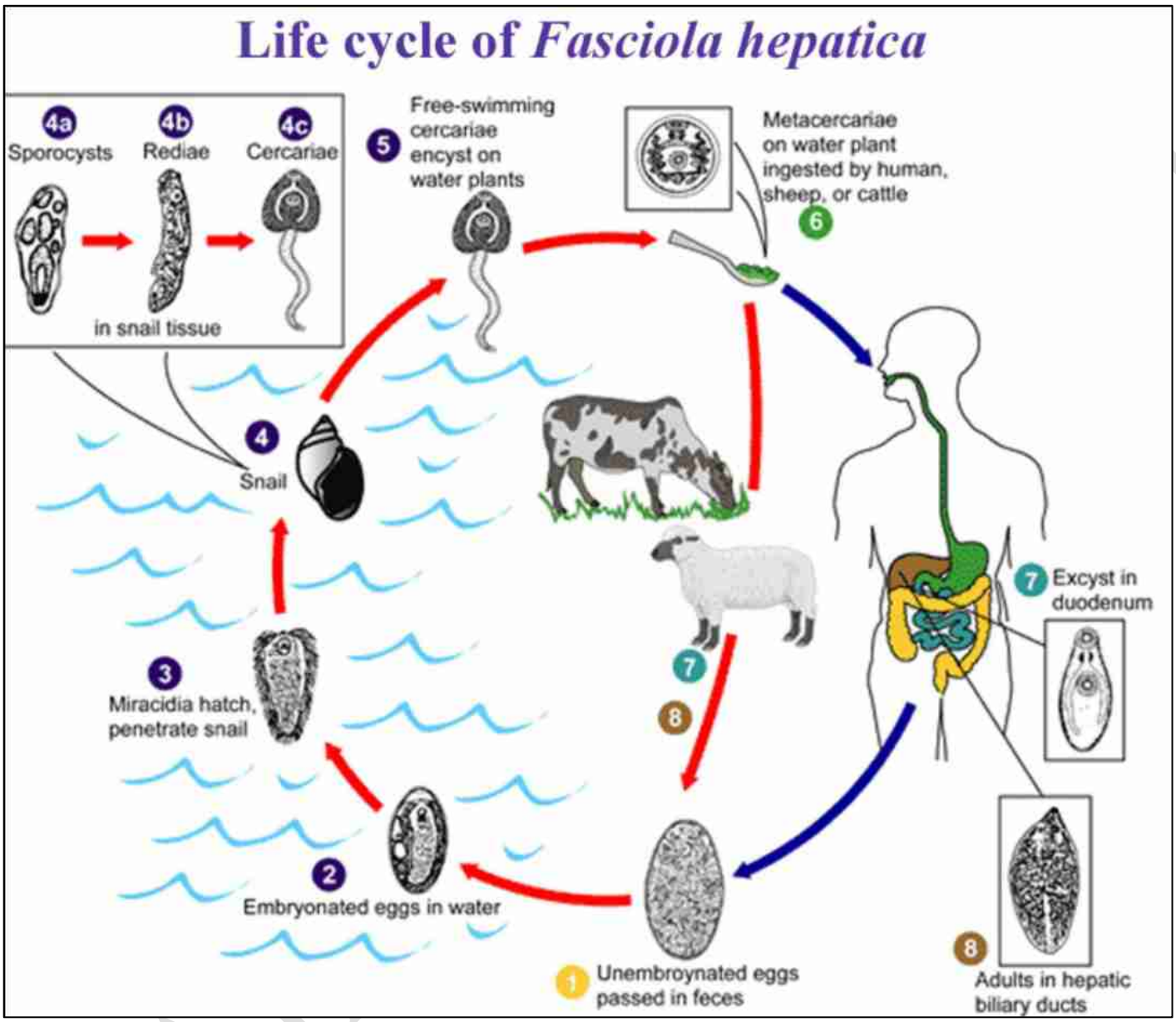
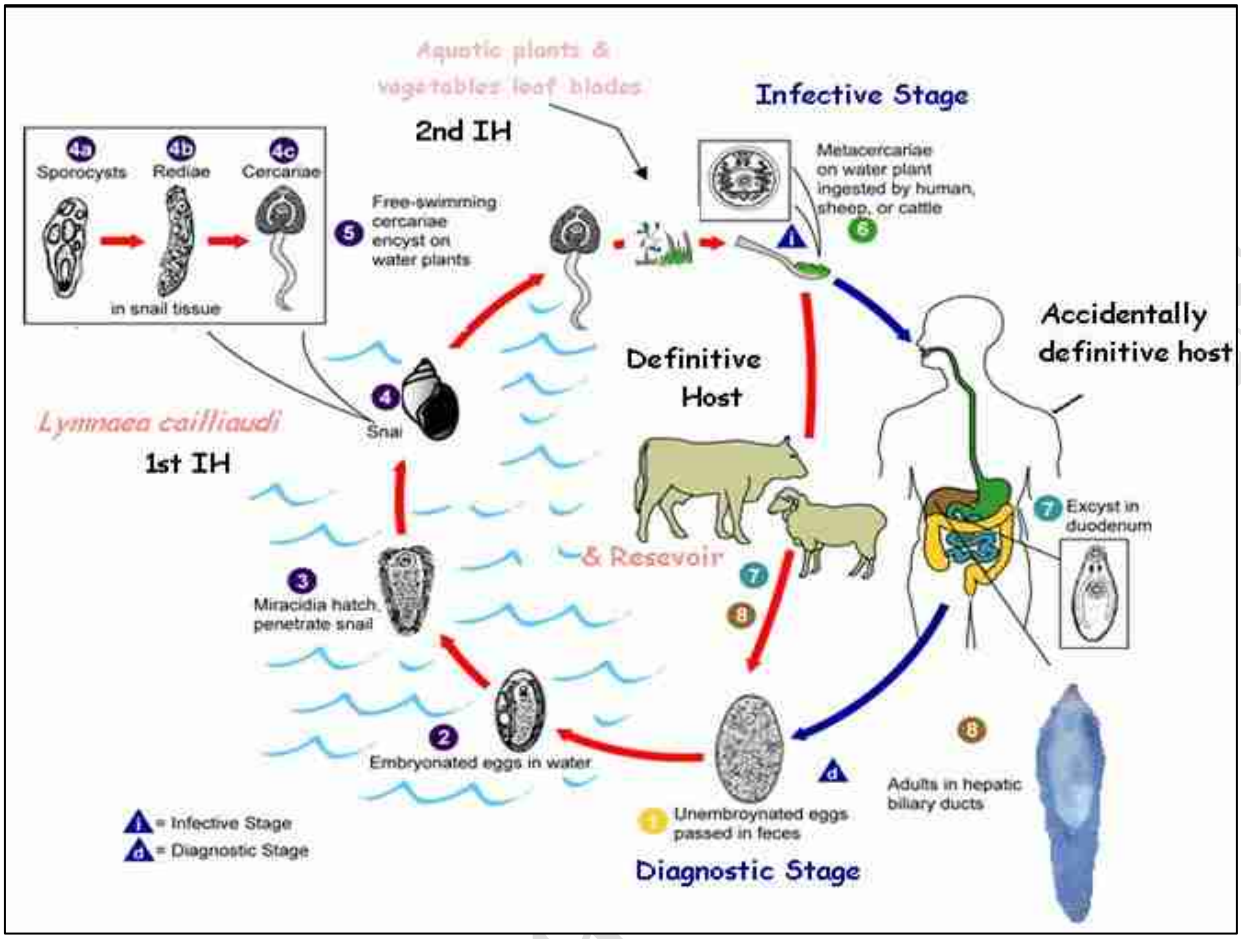
- **Life cycle** of ***Fasciola hepatica*:**



- **Life cycle of *Fasciola gigantica*:**



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2. Blood flukes

- ***Schistosoma haematobium***
- ***Schistosoma mansoni***
- ***Schistosoma japonicum***

- **Background**

  - **Schistosome is** a parasitic trematode worm contracted from infested water that is capable of causing liver, gastrointestinal tract and bladder disease.
  - Three main species of these trematode worms (blood flukes).

- **Scientific Classification:**

  - Kingdom: Animal
  - Phylum: Platyhelminthes
  - Class: Trematoda
  - Genus: *Schistosoma*
  - Species:
    1. *Schistosoma mansoi*
    2. *Schistosoma haematobium*
    3. *Schistosoma japonicum*

- ***Schistosoma* have exception than Trematodes:**

  1. Adult have separate sexes.
  2. Adult female is cylindrical.
  3. Intestinal caeca is reunite.
  4. Ova have spine.
  5. No Redia and metacercaria stages.

- **The habitat of the *Schistosoma* species:**

  1. *Schistosoma mansoi* in the veins of the rectum and the lower part of small intestine.
  2. *Schistosoma haematobium* in the veins of the urinary bladder.
  3. *Schistosoma japonicum* in the veins of the upper part of intestine.

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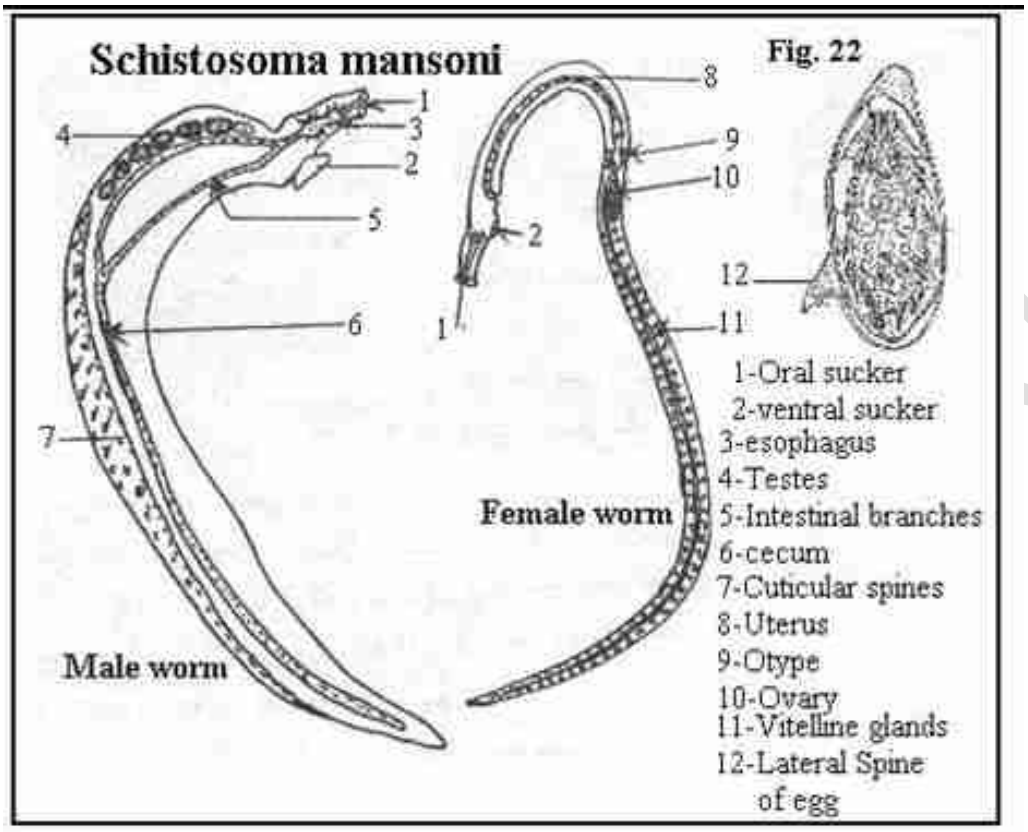
- **Morphology**



➢ **Adult male:**

- Flattened.
- Size: short 10 x 1 mm.
- Well–developed suckers.
- Posterior end is curved ventrally to form Gynaecophoric canal.
- Cuticle provided with tubercles.

➢ **Adult female:**

- Long and slender.
- Size: 20 x 0,2 mm.
- Suckers are weakly developed.
- Cylindrical with smooth cuticle.

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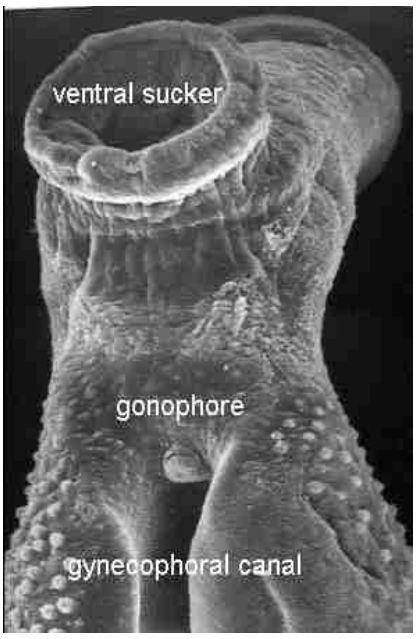
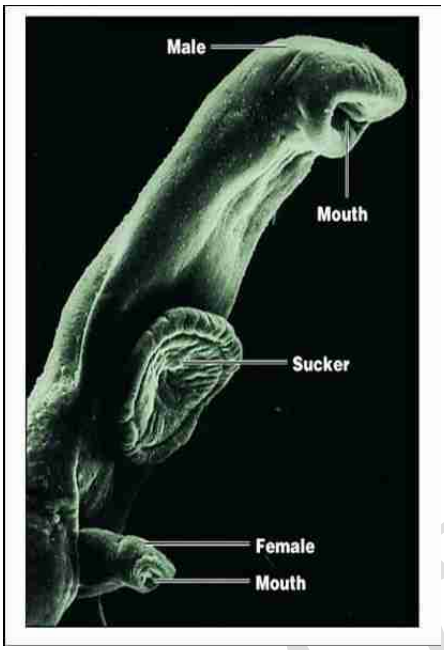
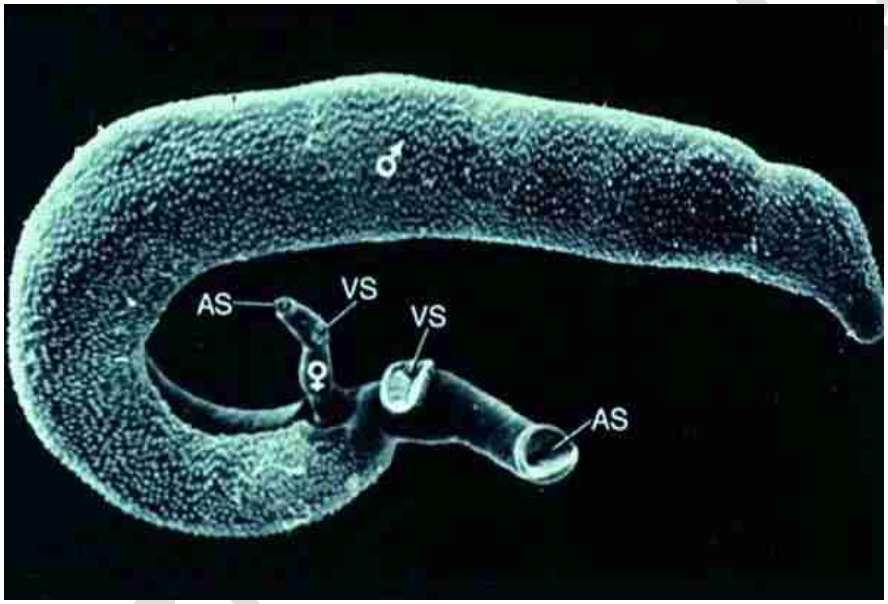
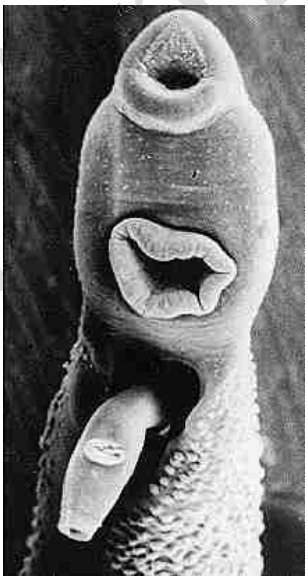
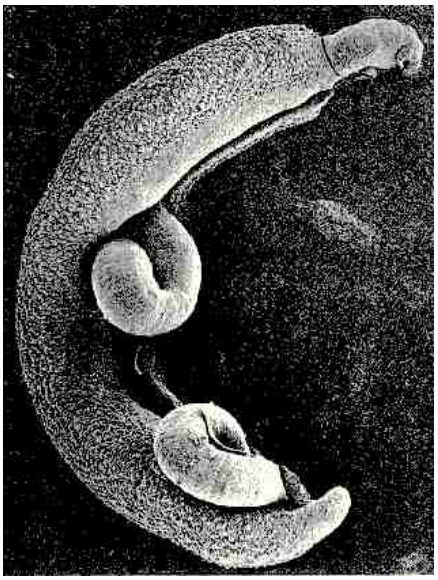

ventral sucker
gonophore
gynecophoral canal

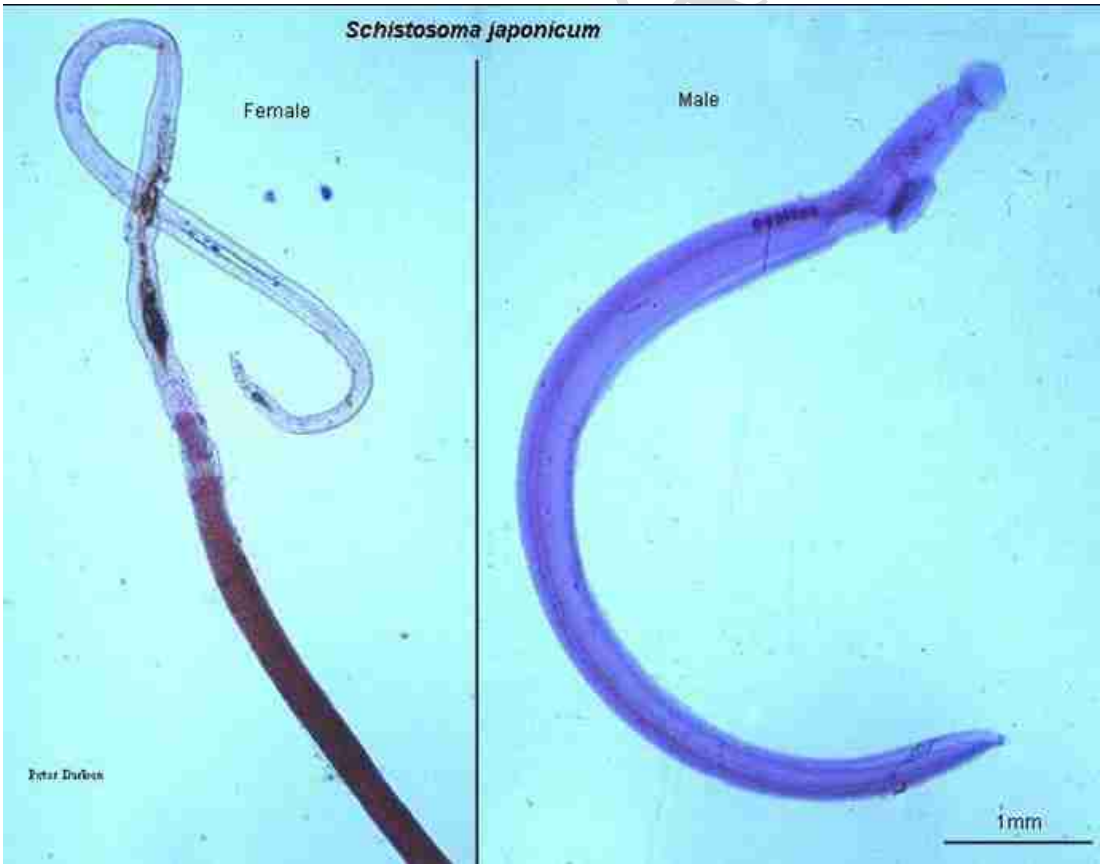

Male
Mouth
Sucker
Female
Mouth


♂
AS
VS
VS
♀
AS





Schistosoma mansoni
Female
Male
40µm


Schistosoma japonicum
Female
Male
1mm

- **Eggs**

	Schistosoma mansoni	***Schistosoma haematobium***	***Schistosoma japonicum***
Size:	150 x 60 µm	140 x 60 µm	80 x 60 µm
Shape:	Oval,with one well rounded pole and one conical pole.	Oval, with one well rounded pole.	Oval, almost round.
Spine:	Lateral	Terminal	-
Content:	Miracidium	Miracidium	Miracidium
Color:	Translucent	Translucent	Translucent

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➢ Miracidium and Cercaria

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- **Disease**
  - They caused **Schistosomiasis**.
  - Schistosomiasis, also known as bilharzia or "snail fever", is a disease caused by parasitic flatworms called schistosomes. The urinary tract or the intestines may be infected.
  - Water-borne parasitic helminth.
- **Mode of infection:**
  - Infective stage (cecariae) penetrates the skin.
- **Definitive host:** Human
- **Intermediate host:** Snail
  - *Biomphalaria alexandrina* in case *S. mansoni*.
  - *Bulinus trancatus* in case *S. haematobium*.
  - *Oncomelania* in case *S.japonicum*.
- **Infective stage**:
  - Furccercus cercaria.
- **Diagnostic stage:**
  - Eggs.

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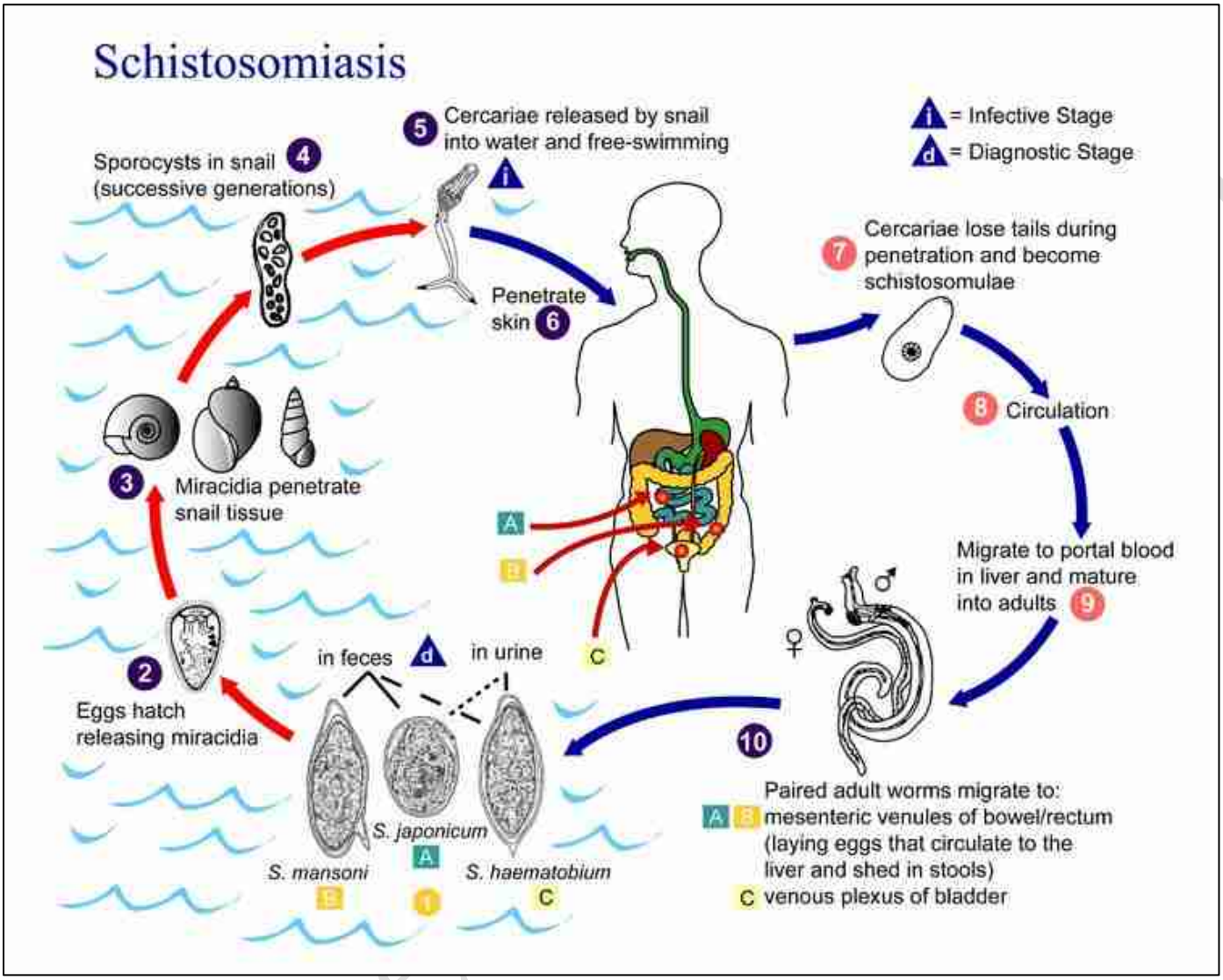
- **Life cycle**


Schistosomiasis
= Infective Stage
= Diagnostic Stage
5 Cercariae released by snail into water and free-swimming
Sporocysts in snail 4 (successive generations)
Penetrate skin 6
7 Cercariae lose tails during penetration and become schistosomulae
8 Circulation
3 Miracidia penetrate snail tissue
Migrate to portal blood in liver and mature into adults 9
in feces
in urine
2 Eggs hatch releasing miracidia
10
Paired adult worms migrate to:
A B mesenteric venules of bowel/rectum (laying eggs that circulate to the liver and shed in stools)
C venous plexus of bladder
S. japonicum
S. mansoni
S. haematobium

❑ **Compare between *Schistosoma mansoni* and *Schistosoma hematobium***

	Schistosoma mansoni	***Schistosoma hematobium***
Location	Veins of **large intestine**, colon (lower mesentric vein	Veins of **urinary** bladder (venous plexus of urinary bladder
Interm. host	*Biomphalaria alexandrina*	*Bulinus truncatus*
Diagnosis	*Eggs in stool*	*Eggs in urine*
Infective stage	*Cercariae*	*Cercariae*
Mode of transmission	Direct skin penetration of cercariae during swimming	
Disease:	**Intestinal** Bilharziasis	**Urinary** Bilharziasis

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3. Intestinal flukes:

- *Heterophyes heterophyes*

- **Scientific Classification**
  - Kingdom: Animal
  - Phylum: Platyhelminthes
  - Class: Trematoda
  - Genus: *Heterophyes*
  - Species: *Heterophyes heterophyes.*

- **Common name: Fish flukes (intestinal flukes)**
- **Disease:**
  - It causes Heterophyiasis (inflammatory reaction of intestine tract).

- **Distribution:**
  - Egypt, Far East, Middle East and Africa**.**
- **Habitat:**
  - Small intestine of man, dog, cat and fox.
- **Definitive host:**
  - Human.
- **Intermediate hosts:**
  - The first one: Snails (*Prienella conica*).
  - The second one: Fish.
- **Reservoir host:**
  - Fish eating animals (as cats, dogs, birds, ..).

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***Prienella conica* Snail**

- **Morphology of *Heterophyes heterophyes***

  - **Adult**

    - Smallest intestinal flukes worms.
    - **Size:** 1.0 – 1.7 mm x 0.3 – 0.7 mm.
    - **Shape:** pear shaped with 3 suckers (Oral, ventral,Genital).

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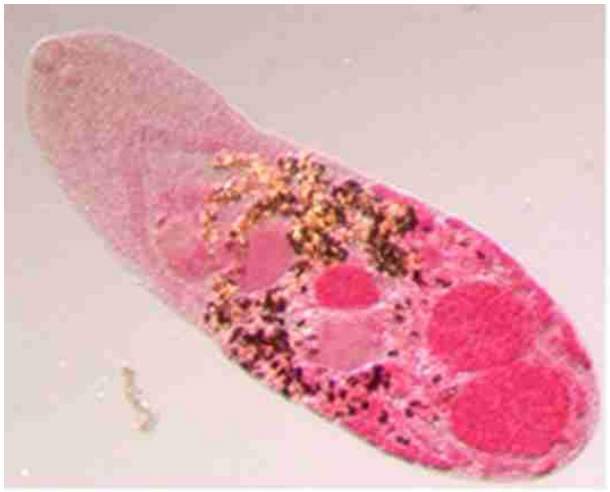
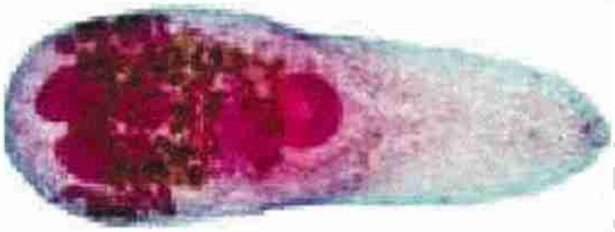
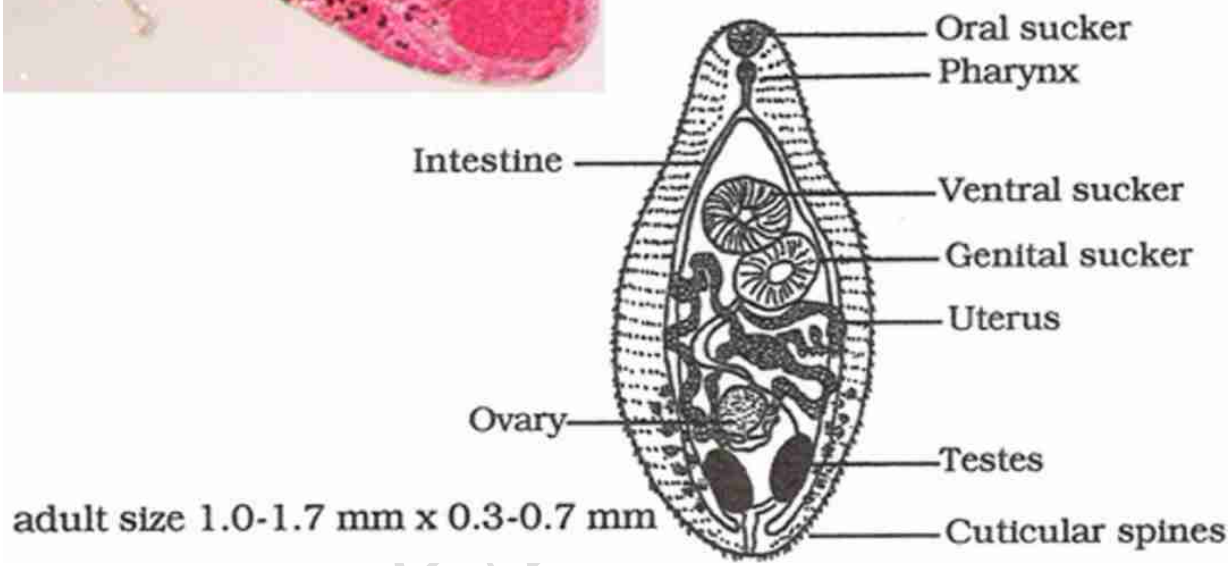
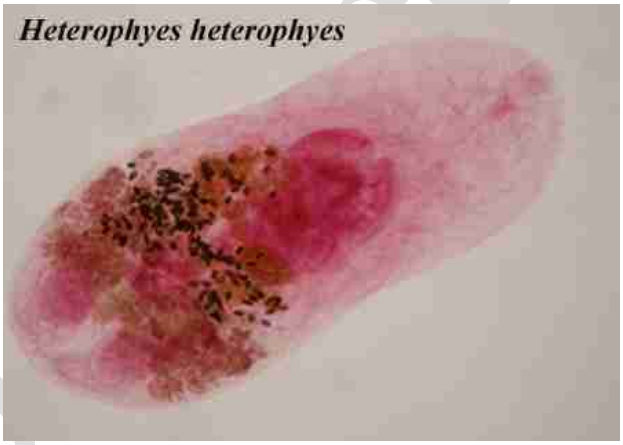
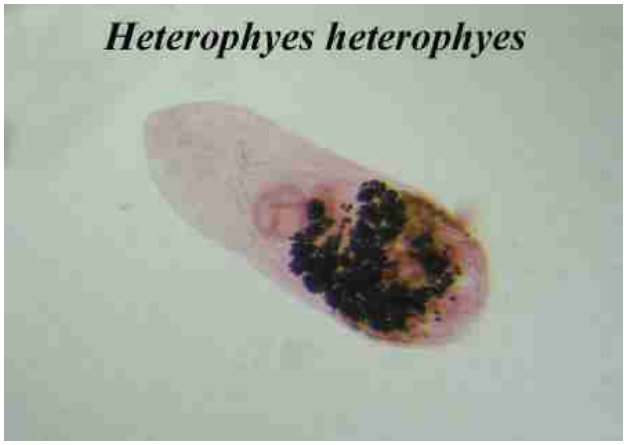




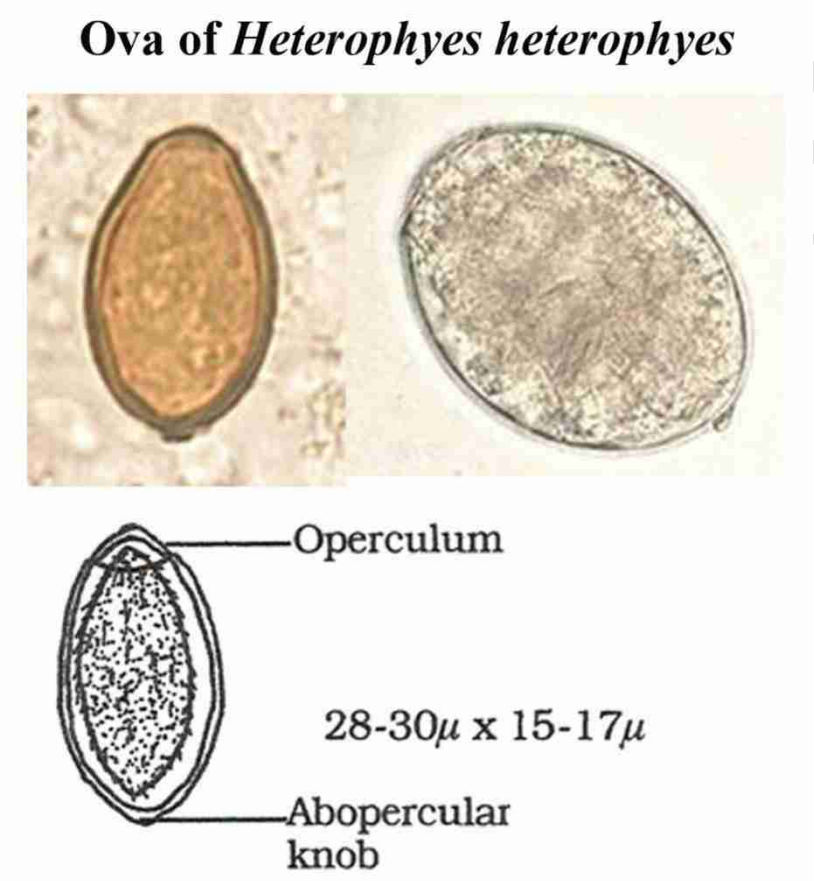

Oral sucker
Pharynx
Intestine
Ventral sucker
Genital sucker
Uterus
Ovary
Testes
Cuticular spines
adult size 1.0-1.7 mm x 0.3-0.7 mm

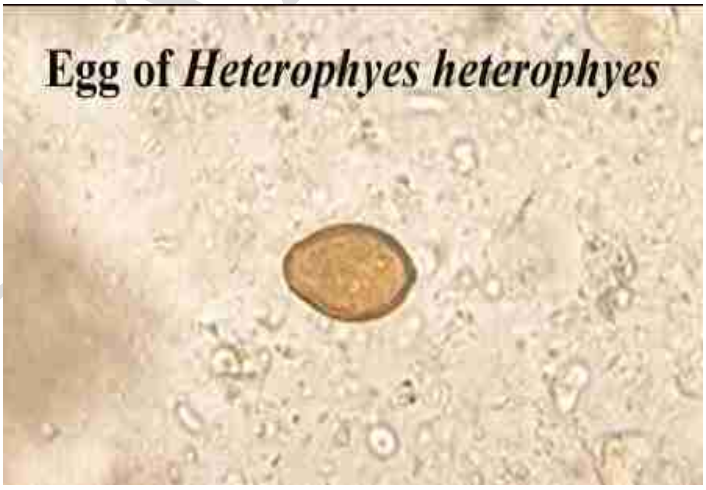

Heterophyes heterophyes

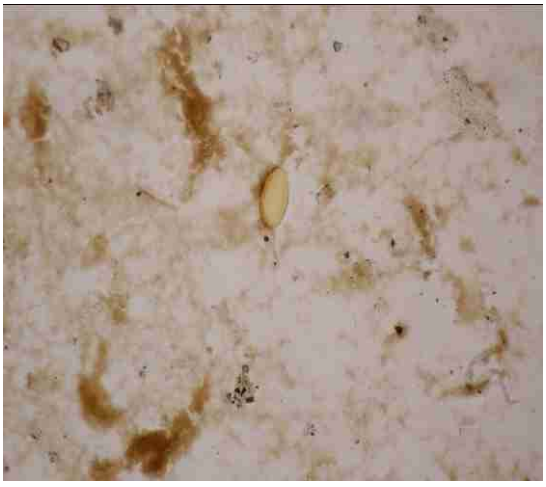

Heterophyes heterophyes

➢ **Egg:**

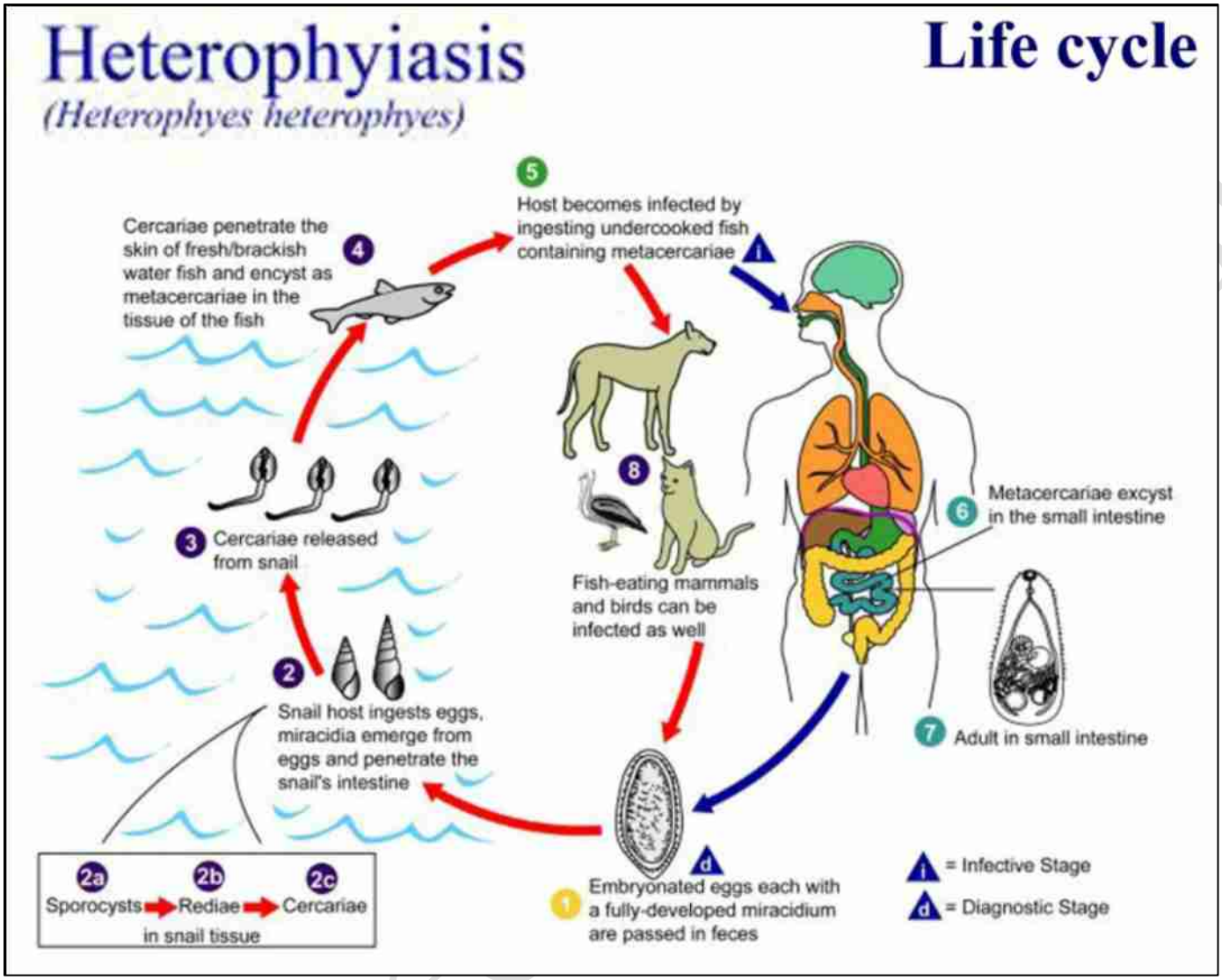
- **Size:** 30 x 15 µm.
- **Shape:** Oval, thick shelled, operculated at one pole and knob at other pole.
- **Color:** Yellowish brown in color.
- **Content:** Miracidium.







- **Life cycle**



- **Diagnostic Stage:**
  - Eggs in stool (yellowish oval eggs containing mature miracidium).
- **Infective Stage:**
  - Encysted metacercaria in fish muscles.
- **Mode of infection:**
  - The disease occurs when humans eat undercooked or raw fish from freshwater or brackish water containing metacercariae (encysted stage) in their muscles.
- **Diagnosis**
  - By finding eggs in the feces.

4. Lung flukes:

- *Paragonimus westermani*

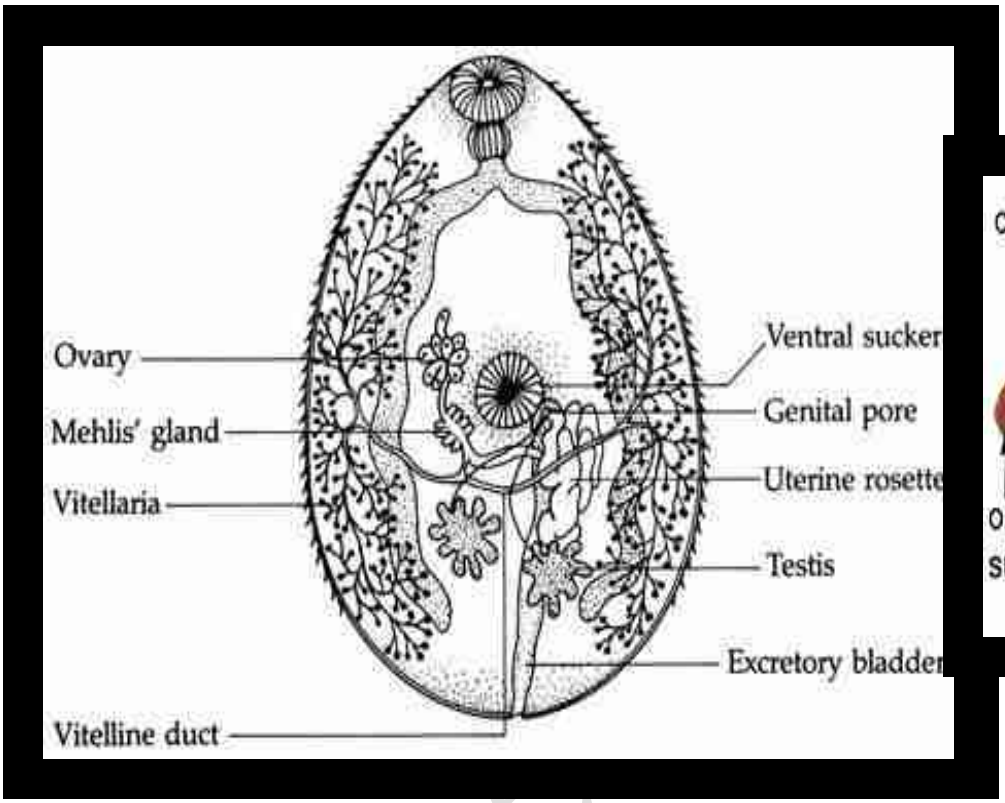
- **Scientific Classification**
  - Kingdom: Animal
  - Phylum: Platyhelminthes
  - Class: Trematoda
  - Genus: *Paragonimus*
  - Species: *Paragonimus westermani*.
- **Disease:**
  - Pragonimasis.
    - It is a food-borne parasitic disease.
    - It may cause a sub-acute to chronic inflammatory disease of the lung
- **Distribution:**
  - Far east.
- **Habitat:**
  - Lung.
- **Definitive host:**
  - Human.
  - Any animal that eats crustaceans.
- **Reservoir host:**
  - Dogs, cats, Pigs and monkeys.
- **Intermediate Hosts:**
  - First intermediate host: a freshwater snails.
  - Second intermediate host: crustaceans as fresh water crabs, shrimps and crayfish.
- **Mode of infection:** infective stage (metacercariae) can be transmitted to human by eating crustaceans uncooked.

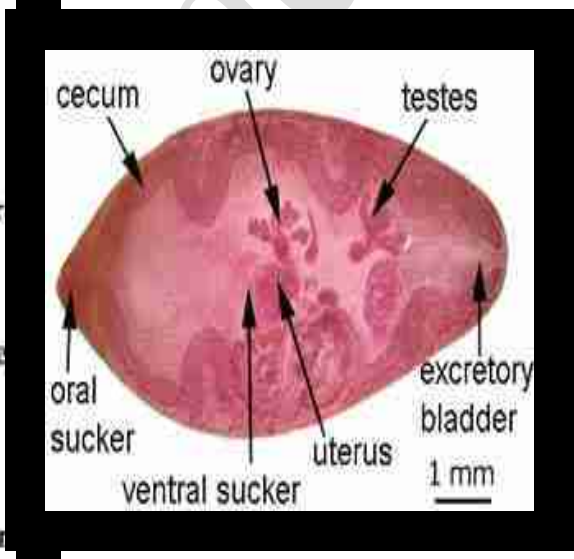
D. Ameera Al-Qadasi

- **Morphology**
  - **Adult:**

    - **Size:** 14 x 7 mm.
    - **Shape:**

      Thick, oval, reddish brown in color.





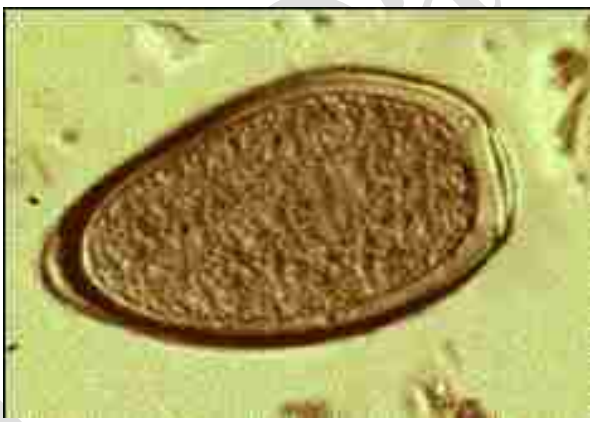
  - **Egg:**

    - **Size:** 90 x 55 µm.
    - **Shape:**

      Oval, thick shelled, operculated at one pole and thickened at other pole.

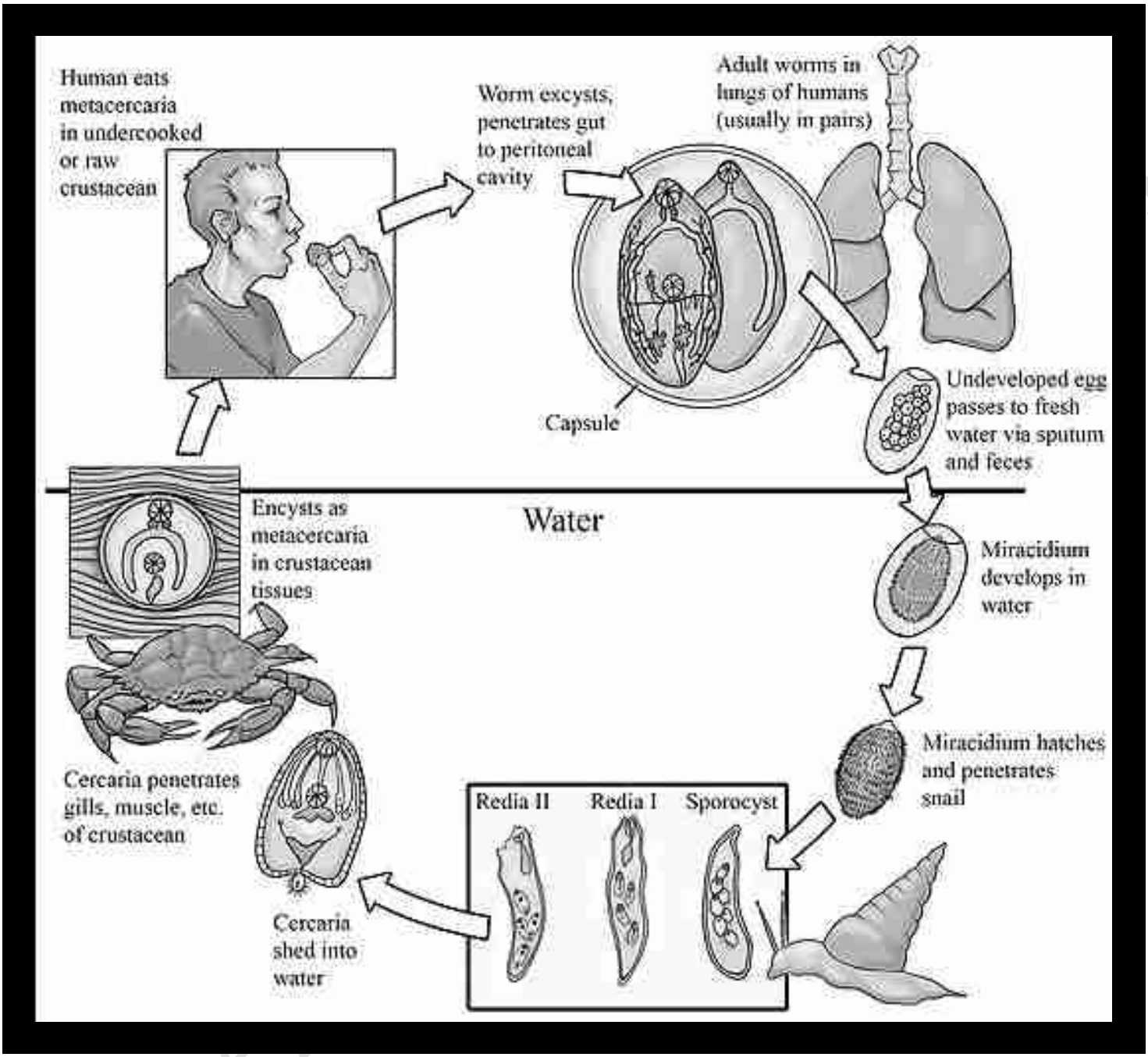
    - **Color:** brown.
    - **Content:** immature ovum.

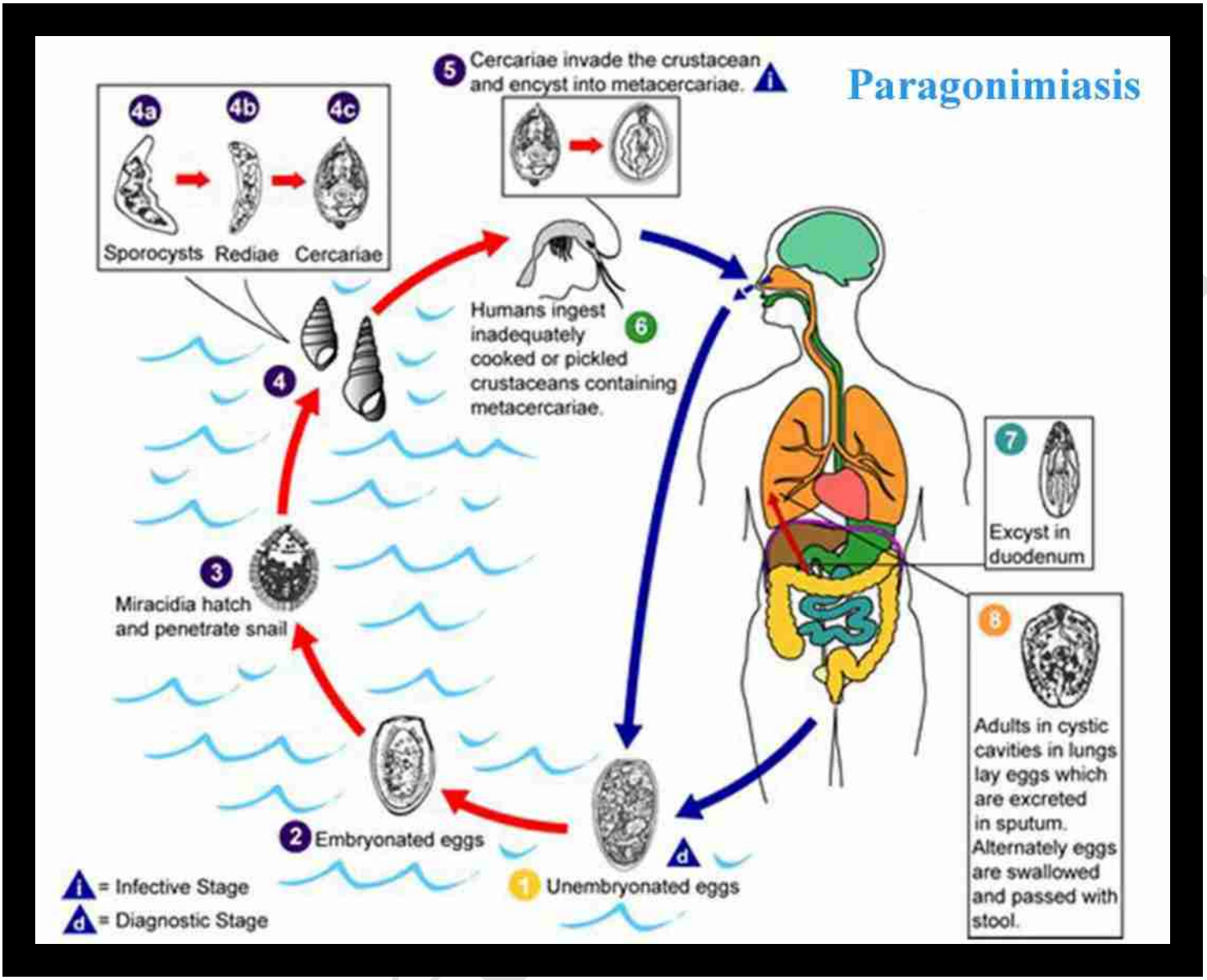
D. Ameera Al-Qadasi



D. Ameera Al-Qadasi

- **Life cycle:**


Human eats metacercaria in undercooked or raw crustacean
Worm excysts, penetrates gut to peritoneal cavity
Adult worms in lungs of humans (usually in pairs)
Capsule
Undeveloped egg passes to fresh water via sputum and feces
Water
Encysts as metacercaria in crustacean tissues
Miracidium develops in water
Miracidium hatches and penetrates snail
Redia II
Redia I
Sporocyst
Cercaria penetrates gills, muscle, etc. of crustacean
Cercaria shed into water


Paragonimiasis
5 Cercariae invade the crustacean and encyst into metacercariae. i
4a
4b
4c
Sporocysts
Rediae
Cercariae
Humans ingest inadequately cooked or pickled crustaceans containing metacercariae.
6
4
3
Miracidia hatch and penetrate snail
2 Embryonated eggs
1 Unembryonated eggs
d
7
Excyst in duodenum
8
Adults in cystic cavities in lungs lay eggs which are excreted in sputum. Alternately eggs are swallowed and passed with stool.
i = Infective Stage
d = Diagnostic Stage

D. Ameera

2. Cestodes (Tape-worms)

- **General characters of Cestodes**
  1. Flat, segmented intestinal parasites.
  2. All tapeworms lack digestive systems.
  3. Monoecious (each segment) contains reproductive system highly developed.
  4. All species are parasitic.
  5. All possess the same general body plan.

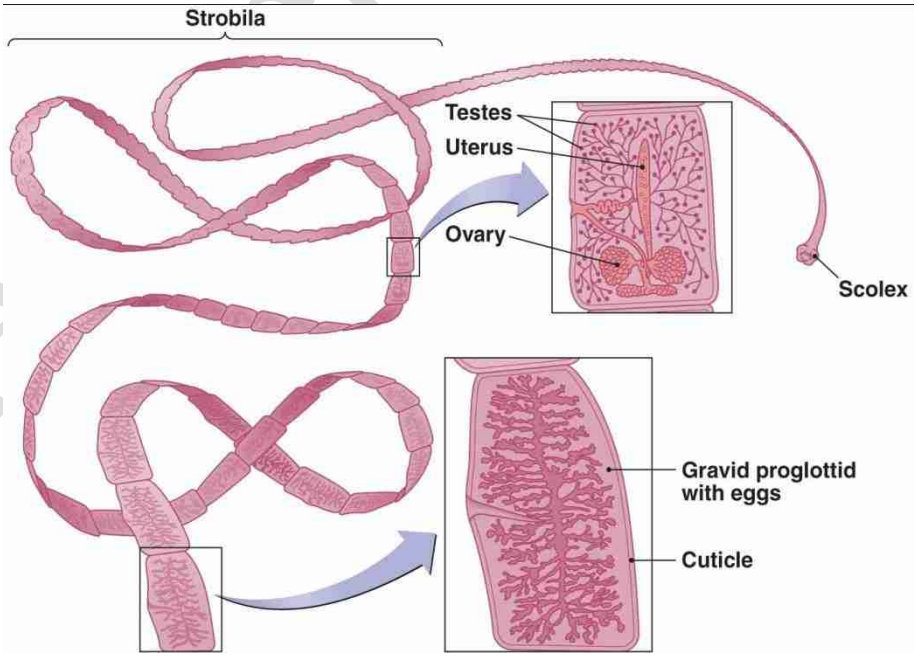
- **Morphology of worm:**

  Three regions of worm body:

  a. Scolex: suckers, hooklets, grooves.

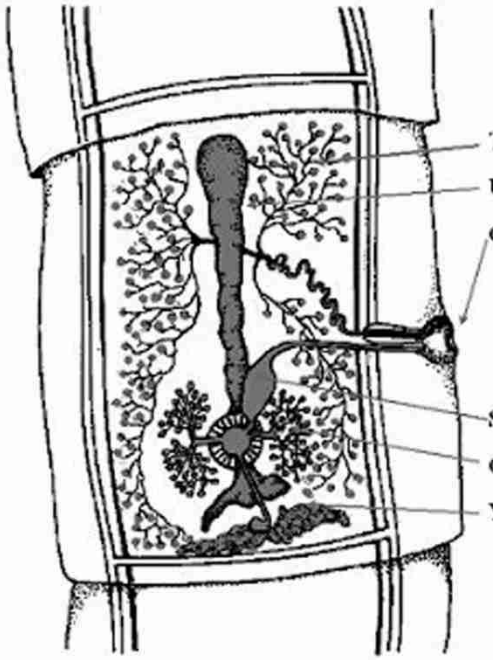
  b. Neck: germinal portion.

  c. Strobila: immature, mature, gravid proglottids (segments).

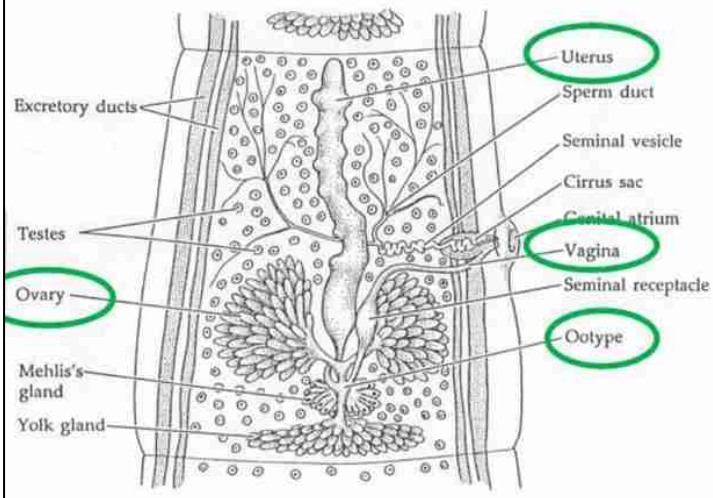


D. Ameera Al-Qadasi

Structure of sexual mature proglottid of cestode

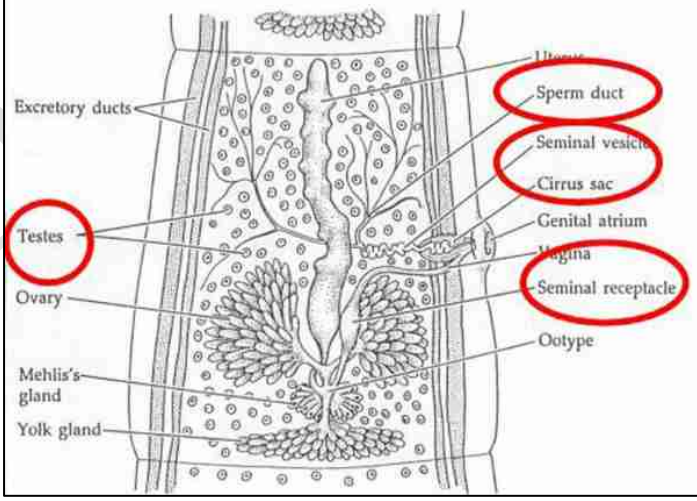


Structure of muture proglottid of cestode



For the female parts, it comprises of:

- **The ovaries**
- **Oviduct**
- **Ootype**
- **The uterus (extend from the ootype)**
- **Vagina**



The male part of the tapeworm consists of:

- **Many testes**
- **Single-coiled sperm duct**
- **Cirrus**
- **Genital atrium**

- **Classification of Cestode :**

1. **Pseudophyllidean:**
   - *Diphyllobothrium latum*
2. **Cyclophllidean (intestinal cestode):**
   - *Teania saginata*
   - *Teania solum*
   - *Hymenolepis nana*
   - *Hymenolepis diminuta*
   - *Dipylidium caninum*
3. **Systemic cestode:**
   - *Echinococcus granulosus*

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- **Pseudophyllidean**
  - ***Diphyllobothrium latum***

- **Scientific Classification**
  - Kingdom: Animal
  - Phylum: Platyhelminthes
  - Order :Pseudophylidea
  - Class: Cestoidea
  - Subclass: Cestoda
  - Genus: *Diphyllobothrium*
  - Species: *Diphyllobothrium latum.*

- **Common name: The Broad Fish Tapeworm.**

- **Disease:**
  - It causes **Diphyllobothriasis (Fish Tape worm infection);** it is human infection is caused by ingestion of raw or inadequately cooked fish infected with the plerocercoid larva.

- **Distribution:**
  - Europe, America, Russia, Japan and East Africa

- **Habitat:**
  - In the small intestine.

- **Mode of infection:**
  - Through consumption of raw or undercooked fish.
  - The infective stage for mammals is the **plerocercoid larva**, which is ingested in raw or undercooked fish.
  - Larvae attach to the mucosa lining of the small intestine and develop to adults.

- **Definitive host:**
  - Several fish-eating mammals serve as definitive hosts like:
    - Humans.
    - Cats.
    - Dogs.
    - Bears.

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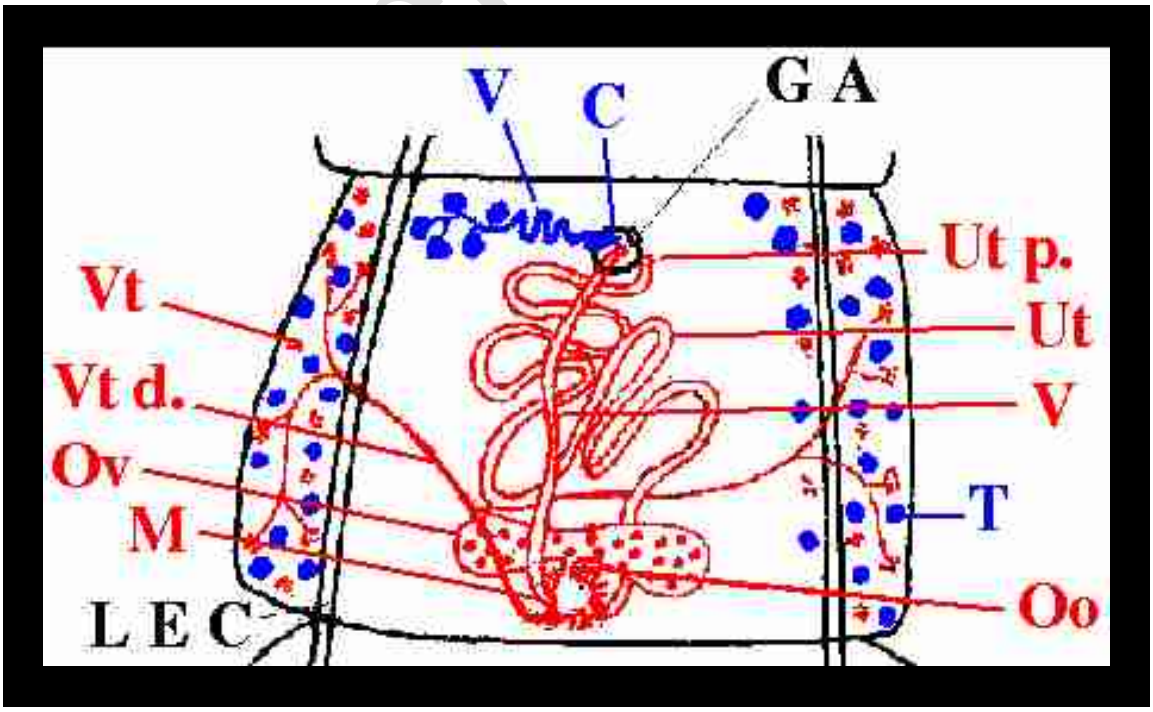
- **Intermediate hosts:**
  - First: Cyclops or Copepods (water flea).
  - Second: Fresh water fish as Salmon.
- **Reservoir host :**
  - Fish eating Animals (Cats & Dogs)
- **Morphology**
  - **Adult stage**
    - *D. latum* is the largest human tapeworm.
    - Size : 3 – 15 meters (and sometimes up to 45 meters)
    - Scolex: Elongated, almond shaped with a pair of suctorial grooves, known as bothria (two groves).
    - Mature segment: Broader than long and has:
      - Testes :Multiple and distributed in the dorsolateral part .
      - Ovary: Bilobed in the posterior part.
      - Uterus:Rosette-Shaped convulated.
      - Common genital pore (C.G.P): In the midventral of the segment.
    - No Gravid segment.



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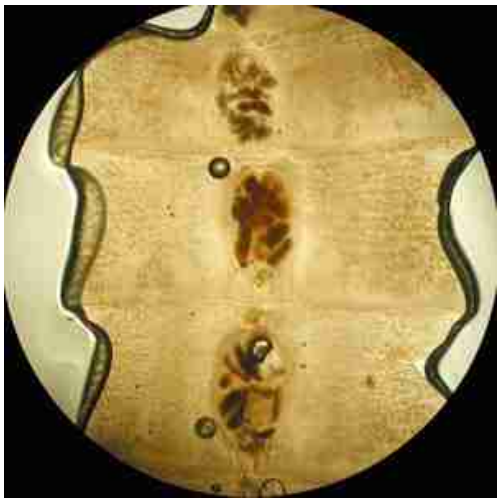

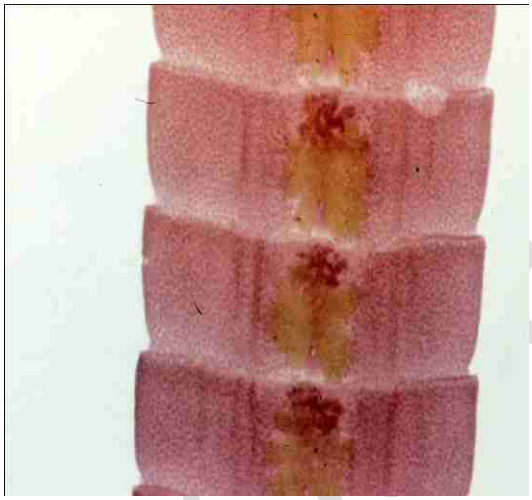

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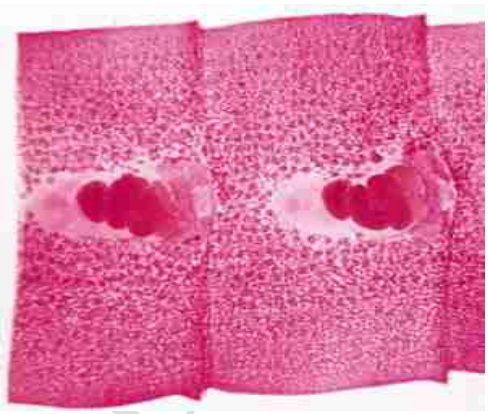

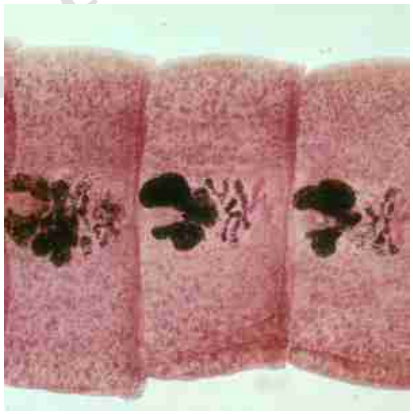

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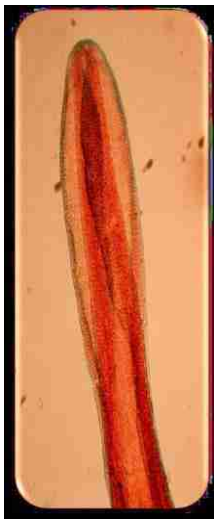

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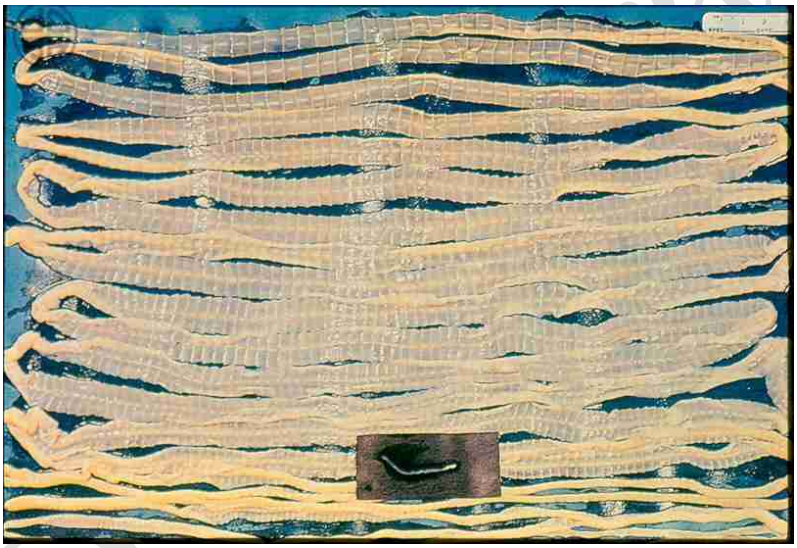

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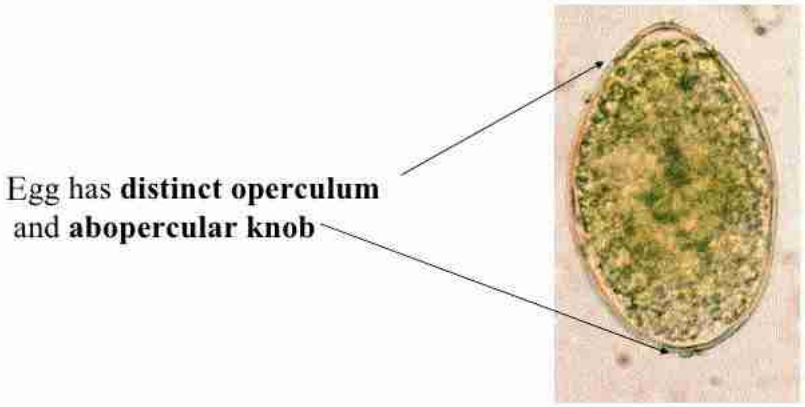
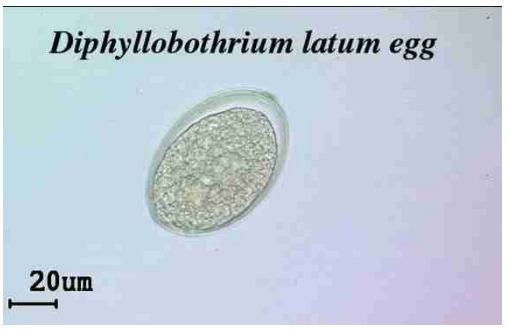
- **Eggs:**
  - Size: 30 x 60 µm.
  - Shape: Oval, operculated and thick shelled (this is the only cestode with an operculated egg).
  - Color: Yellowish brown.
  - Content: Immature ovum.

Egg of *Diphyllobothrium latum*



Egg of *Diphyllobothrium latum*

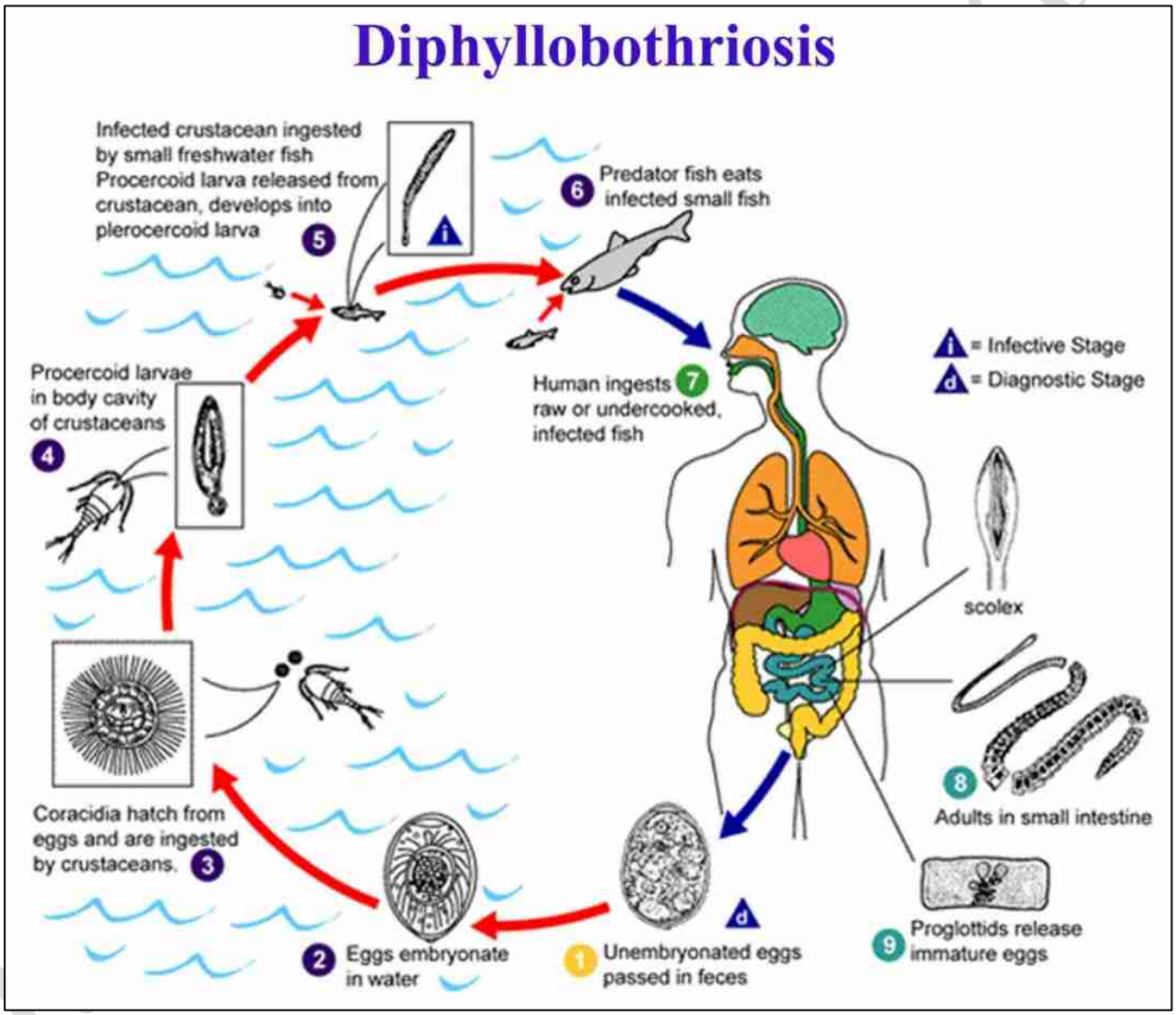
Egg of *Diphyllobothrium latum*



➢ **Larva stage:**

- Procercoid larva:
  - Elongated, with spherical caudal end containing 6 hooks.
- Plerocercoid larva :
  - Elongated with anterior invaginated scolex.
  - The infective stage for Definitive host and Reservoir host.

▪ **Life cycle**


Diphyllobothriosis
Infected crustacean ingested by small freshwater fish
Procercoid larva released from crustacean, develops into plerocercoid larva
5
6 Predator fish eats infected small fish
Procercoid larvae in body cavity of crustaceans
4
Human ingests 7 raw or undercooked, infected fish
i = Infective Stage
d = Diagnostic Stage
scolex
8 Adults in small intestine
Coracidia hatch from eggs and are ingested by crustaceans. 3
2 Eggs embryonate in water
1 Unembryonated eggs passed in feces
9 Proglottids release immature eggs

- **Cyclophllidean (intestinal cestode)**
  - ***Taenia saginata*.**

- **Scientific Classification**
  - Kingdom: Animal
  - Subkingdom: Metazoa
  - Phylum: Platyhelminthes
  - Class: Cestoidea
  - Subclass: Cestoda
  - Order: Cyclophyllidea
  - Family: Taeniidae
  - Genus: *Taenia*
  - Species: *Taenia saginata*.
- **Disease:**
  - Taeniasis *saginata* (a type of helminthiasis) or beef tape-worm infection.
  - Cysticercosis in cattle.
- **Habitat:**
  - In ileum of small intestine of man only.
- **Mode of infection:**
  - By eating undercooked or raw meat (beef) containing infective stage (cysticercus bovis).
- **Infective stage:**
  - Cysticercus bovis (Larva of *Taenia saginata*).
- **Diagnostic stage:**
  - Eggs and gravid segments.
- **Definitive host:**
  - Human only.

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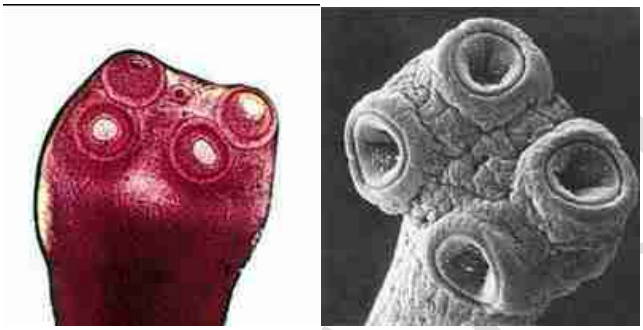
- **Intermediate hosts:**

  - Cattle (Cow and Buffalo).

- **Morphology:**

  - **Adult worm of *Taenia saginata***
    - Size: 4 – 10 meters in length.

    1. Scolex:
    - Globular with 4 suckers (Cup Shaped).
    - No rostellum, or hooks.

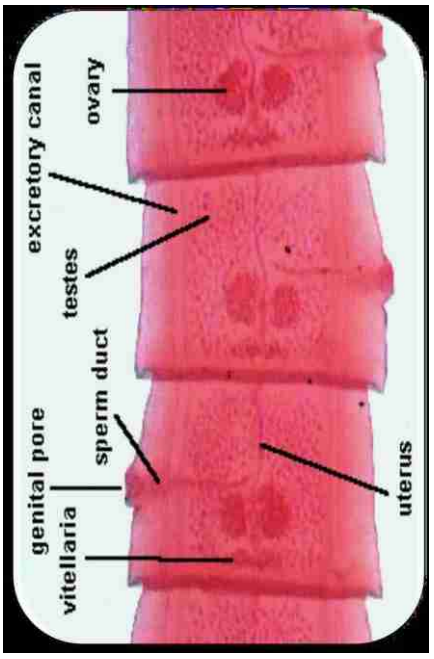


2. Strobila (about 2000 segments)

- **Consists of:**

  a) Immature segments:
  - Broader than long.
  - Lack genital organs (Undifferentiated).

  b) Mature segments: (Squarish)
  - Contains genital organs.
  - Testes: 300- 400 testes.
  - Ovary: Bilobed in the posterior part.
  - Uterus: Longitudinal tube.
  - Vitelline gland: posterior compact mass.
  - Common genital pore: Marginal.



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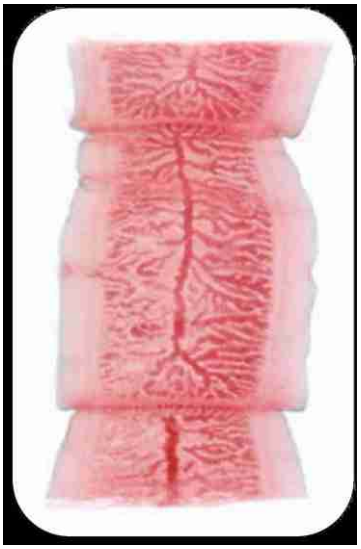
c) Gravid segments:

- Longer than broader.
- Uterus with lateral branches on each side (15-30).



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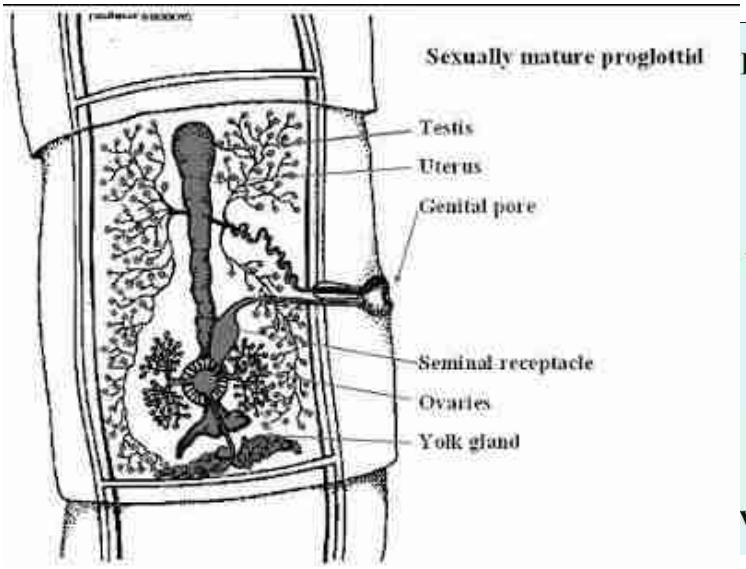
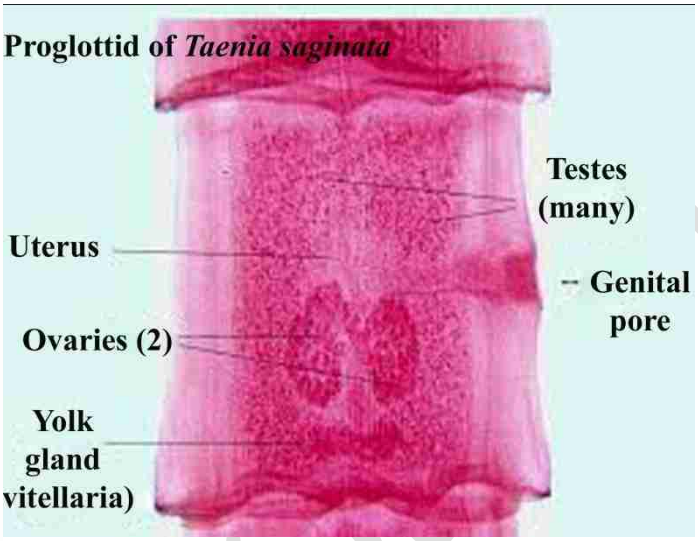
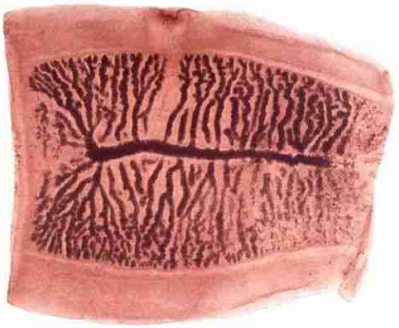
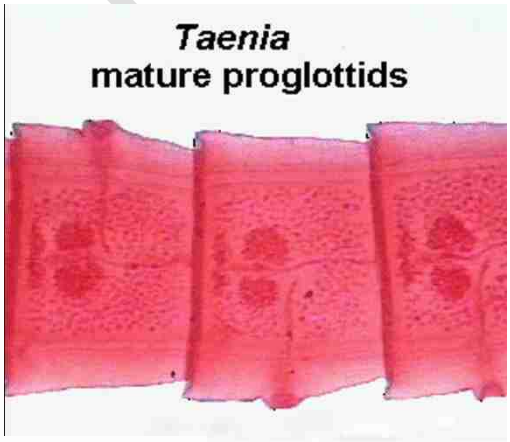


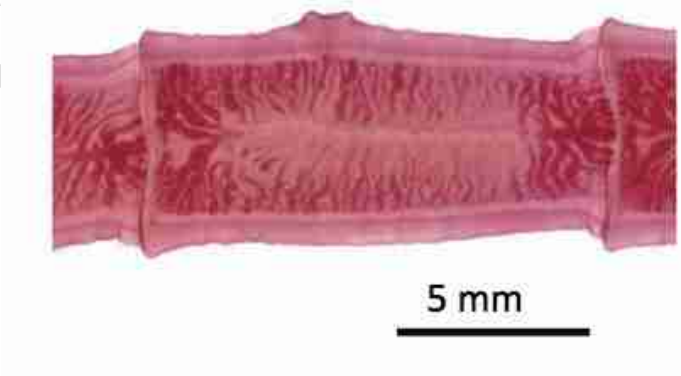


Beef Tapeworm

- Uterine branches in proglottid

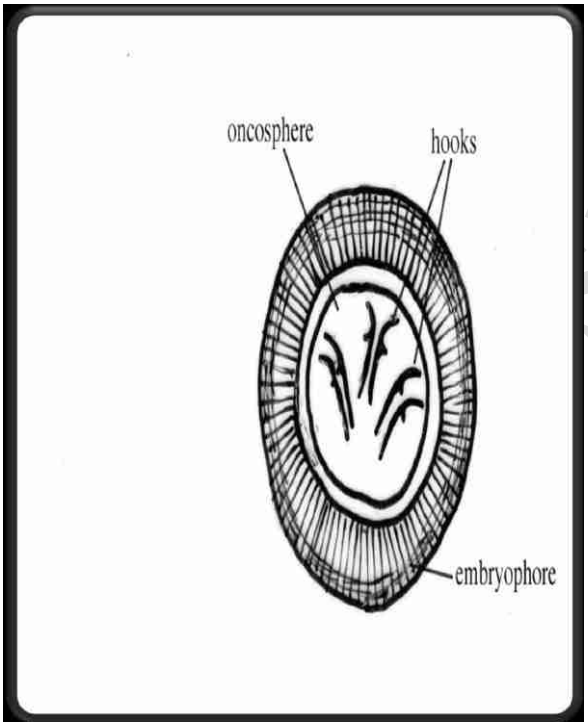






[redacted]

- **Egg of *Taenia saginata***:
  - Size: 40 µm.
  - Shape: Rounded with radially striated shell.
  - Color: Yellowish brown.
  - Content: Hexacanth onchosphere (6-hooked embryo).



D. Ameera Al-Qadasi

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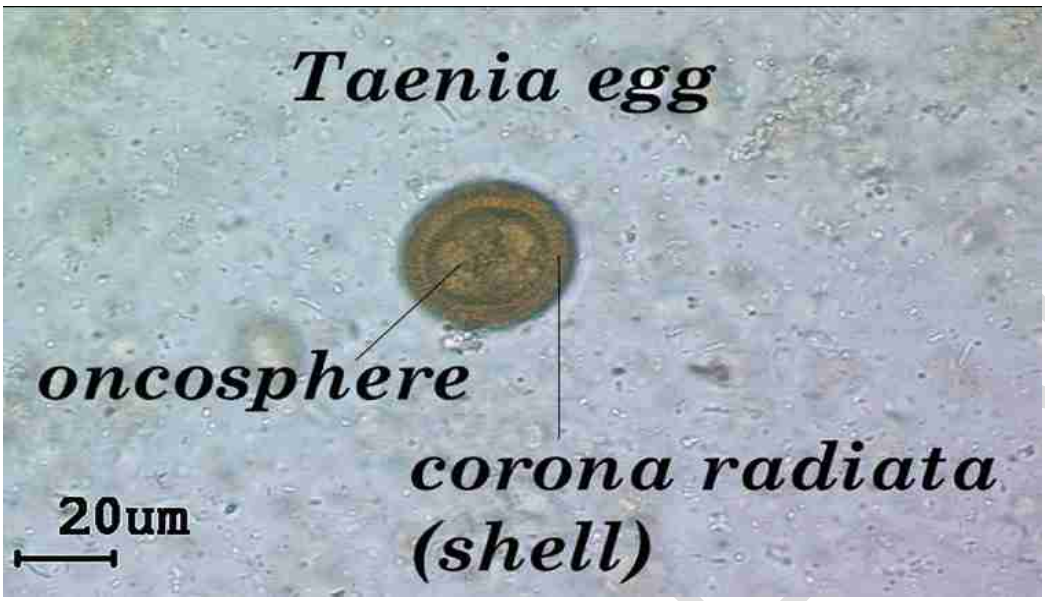
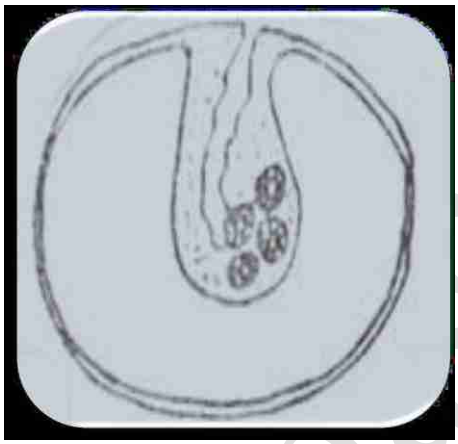


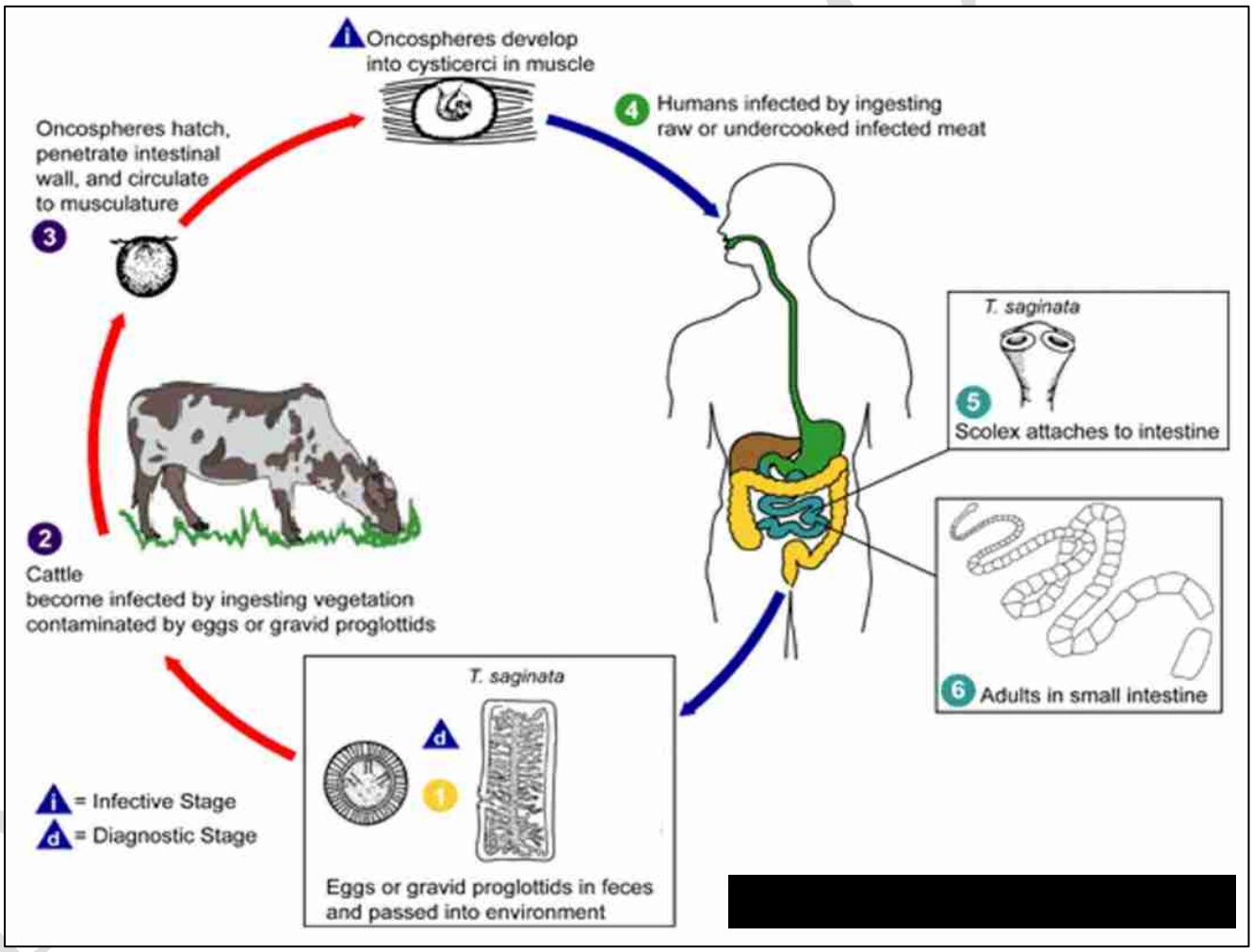
D. Ameera Al-Qadasi

➢ **Larva of *Taenia saginata***:

- Cysticercus bovis (Bladder worm)
  - Size: 10 mm. Shape: Oval.
  - Scolex: Invaginated and carries 4 suckers.



▪ **Live cycle:**


1 Oncospheres develop into cysticerci in muscle
4 Humans infected by ingesting raw or undercooked infected meat
Oncospheres hatch, penetrate intestinal wall, and circulate to musculature
3
T. saginata
5 Scolex attaches to intestine
2
Cattle
become infected by ingesting vegetation contaminated by eggs or gravid proglottids
6 Adults in small intestine
T. saginata
d
1
i = Infective Stage
d = Diagnostic Stage
Eggs or gravid proglottids in feces and passed into environment

➢ ***Taenia solium***

- **Scientific Classification**
  - Kingdom: Animal
  - Subkingdom: Metazoa
  - Phylum: Platyhelminthes
  - Class: Cestoidea
  - Subclass: Cestoda
  - Order: Cyclophyllidea
  - Family: Taeniidae
  - Genus: *Taenia*
  - Species: *Taenia solium*
- **Disease:**
  - Taeniasis *solium* (a type of helminthiasis) or pork tape-worm infection.
  - Cysticercosis in human.
- **Habitat:**
  - In ileum of small intestine of man only.
  - Larva can find in muscles and other organs in human.
- **Mode of infection:**
  - By eating undercooked or raw meat (pork) containing infective stage (cysticercus cellulosae).
- **Infective stage:**
  - Cysticercus cellulosae (Larva of *Taenia solium*).
  - Egg.
- **Diagnostic stage:**
  - Eggs and gravid segments.
- **Definitive host:**
  - Human only.

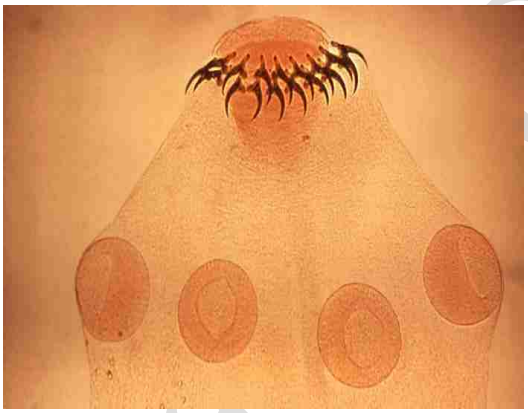
D. Ameera Al-Qadasi

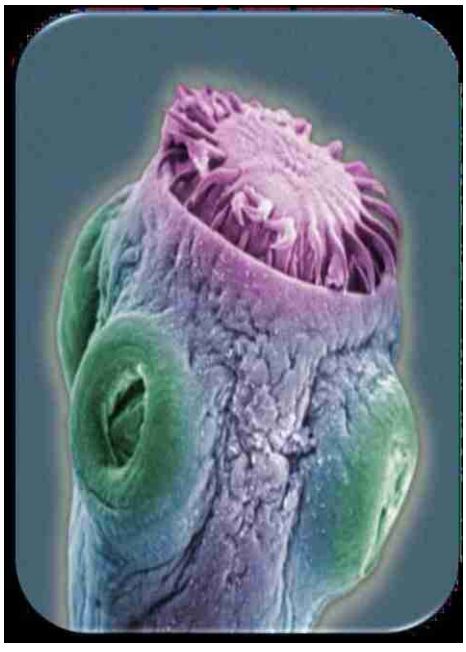
- **Intermediate hosts:**

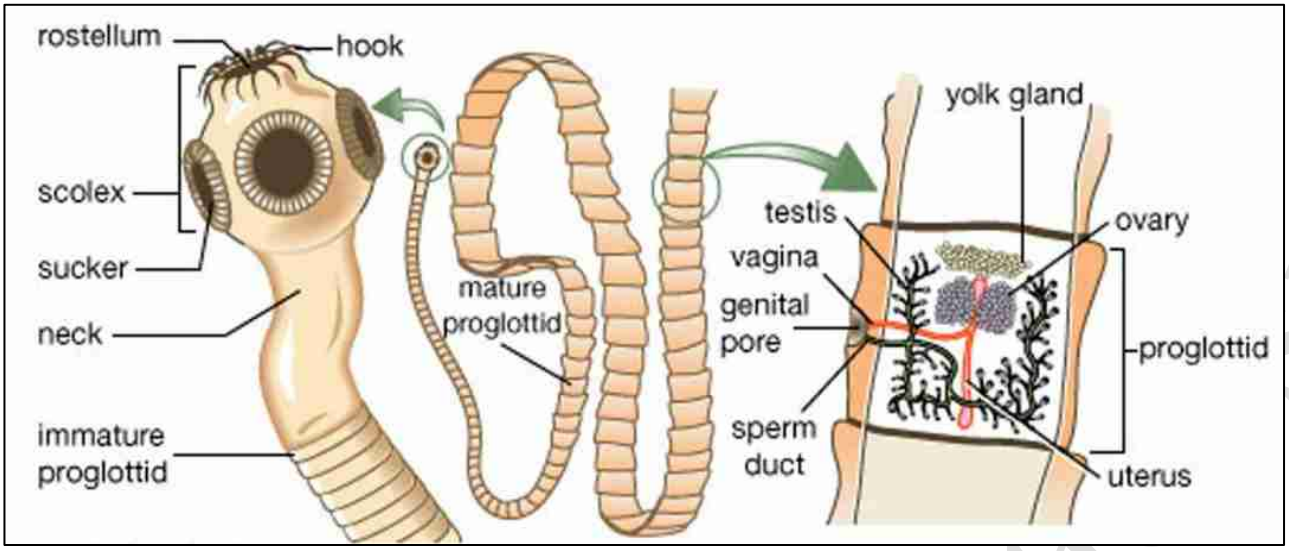
Pig and sometimes man.

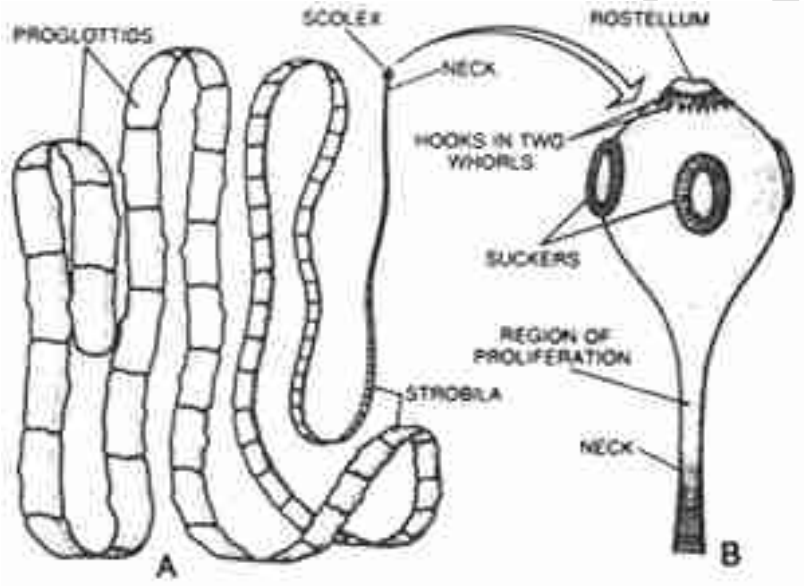
- **Morphology**:

  - **Adult worm is the same of *Taenia saginata* but differ in:**
    1. Size 2–4 meters long.
    2. It has 700-1000 segments.
    3. Scolex has rostellum and two rows of hooks.
    4. Testes about 200, and ovary trilobed.
    5. Gravid segment has a uterus with 7-13 lateral branches.

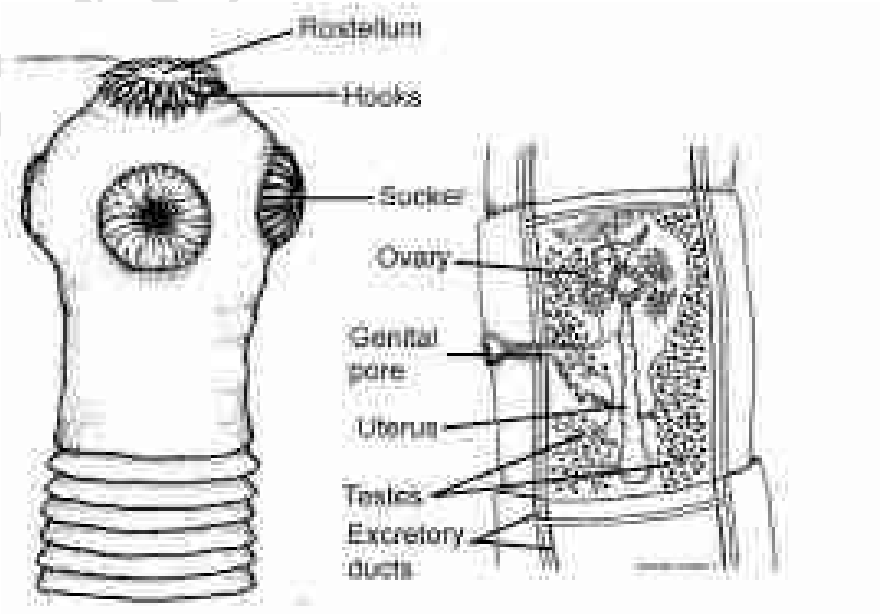


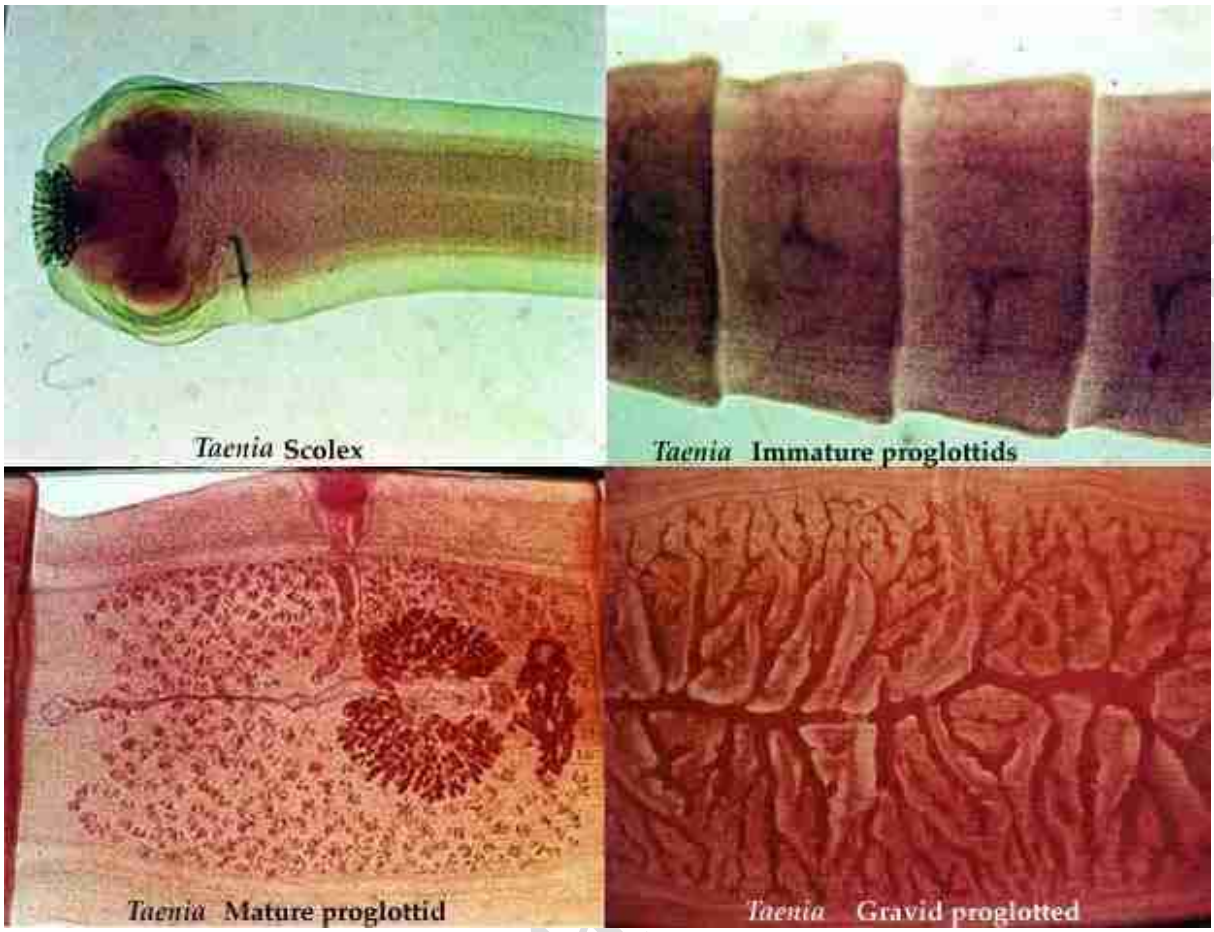






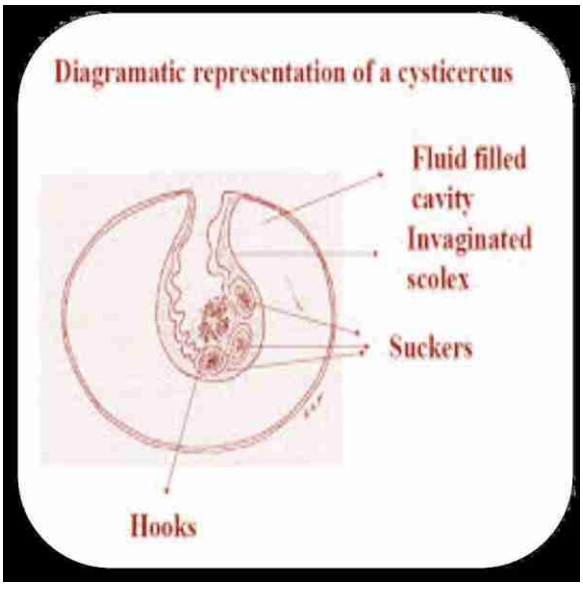
***Taenia solium* : A. whole; B. its scolex**





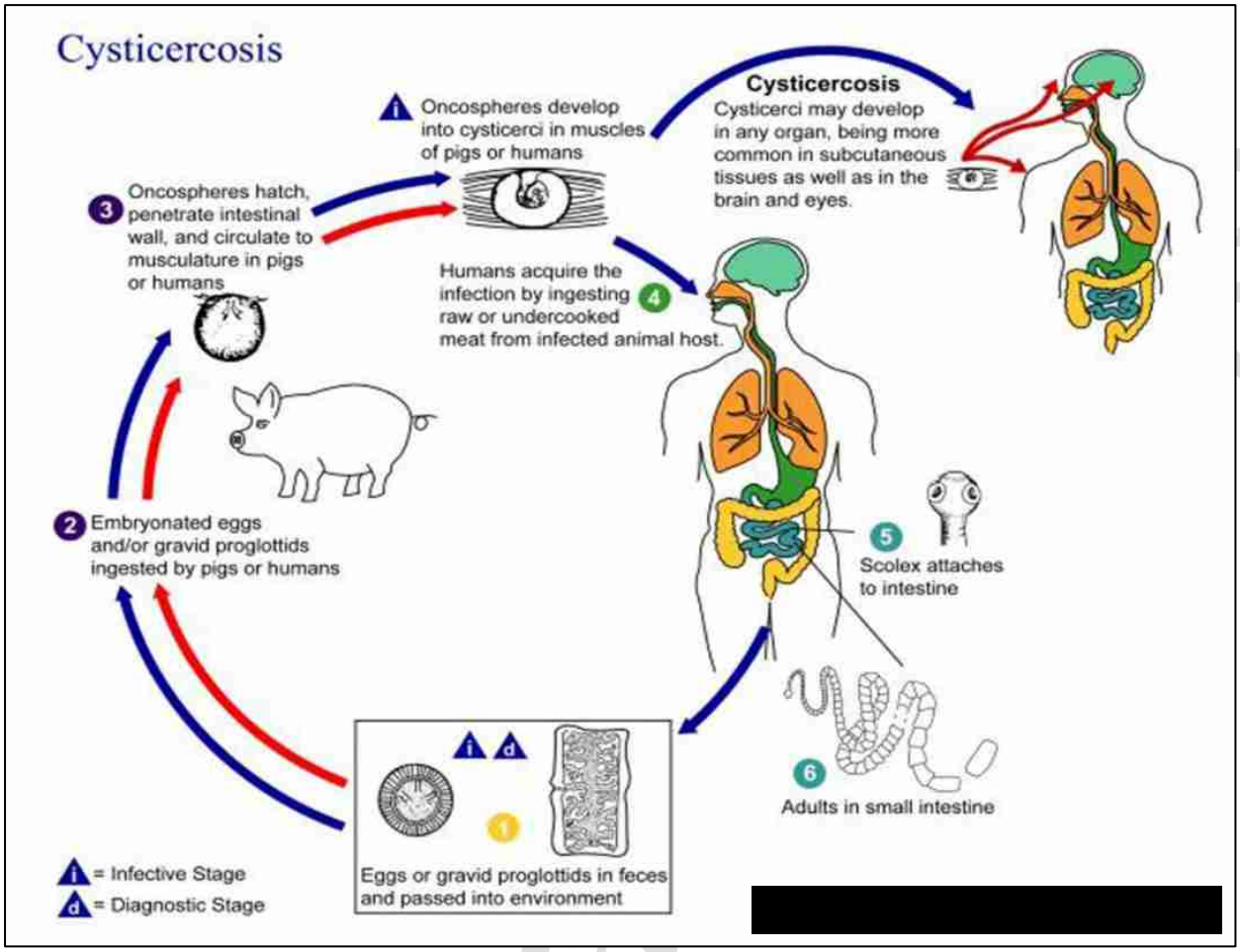
- **Egg of *Taenia solium*:**
  - The same as Taenia saginata egg.
  - Can be differentiated by Ziehl-Neelsen stain ,where *T. saginata* eggs take the stain but *T. solium* egg don't.

- **Larva of Taenia *solium*:**
  - Cysticercus cellulosae.



D. Ameera Al-Qadasi

- **Life cycle**


Cysticercosis
Oncospheres develop into cysticerci in muscles of pigs or humans
Cysticercosis
Cysticerci may develop in any organ, being more common in subcutaneous tissues as well as in the brain and eyes.
Oncospheres hatch, penetrate intestinal wall, and circulate to musculature in pigs or humans
Humans acquire the infection by ingesting raw or undercooked meat from infected animal host.
Embryonated eggs and/or gravid proglottids ingested by pigs or humans
Scolex attaches to intestine
Adults in small intestine
Eggs or gravid proglottids in feces and passed into environment
= Infective Stage
= Diagnostic Stage

D. Ameera Al-Qadasi

➢ *Hymenolepis nana*

- **Scientific Classification**
  - Kingdom: Animal
  - Phylum: Platyhelminthes
  - Class: Cestoidea
  - Subclass: Cestoda
  - Order: Cyclophyllidea
  - Genus: *Hymenolepis*
  - Species: *Hymenolepis nana*.
- **Common name: The dwarf tapeworm**
- **Disease:**
  - Hymenolepiasis.
  - The disease is a type of helminthiasis which is classified as a neglected tropical disease.
- **Distribution:**
  - Cosmopolitan, more common in worm climate.
- **Habitat:**
  - Adult stage in small intestine.
  - Larva stage embedded in the mucosa.
- **Mode of infection:**
  - Autoinfection: from hand to mouth or fecal oral rout.
  - Heteroinfection through the following:
    - Ingestion of contaminated food or drink with eggs
    - Or ingestion of insects containing larvae.
  - Food handlers by flies
- **Definitive host:**
  - Human.
  - Mice.
  - Rats.

D. Ameera Al-Qadasi

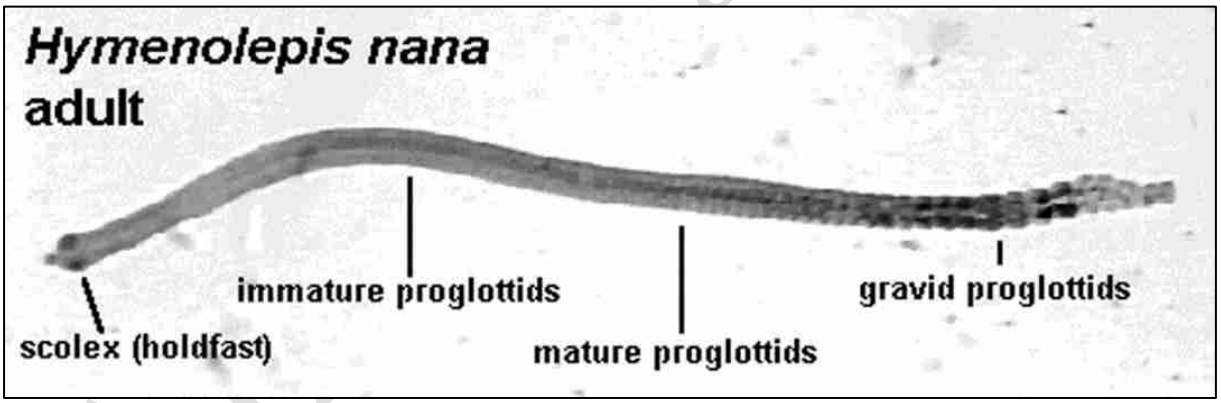
- **Intermediate hosts:**
    - The only cestode that parasitizes humans without requiring an intermediate host, but in sometimes the intermediate hosts are presence and they are:
        - Fleas.
        - Beetles.

- **Human** is the Definitive and Intermediate host.

- **Morphology of *H. nana***

➢ **Adult:**

- Size : 1 – 3 cm.
- Scolex : Globular with 4 suckers, have a rostellum, with one row of 20-30 small hooks.
- Mature segment: Brooder than long, and has:
    - Three testes.
    - One ovary in the center of the segment.
- Common genital pore (C.G.P): on the same side of strobila.



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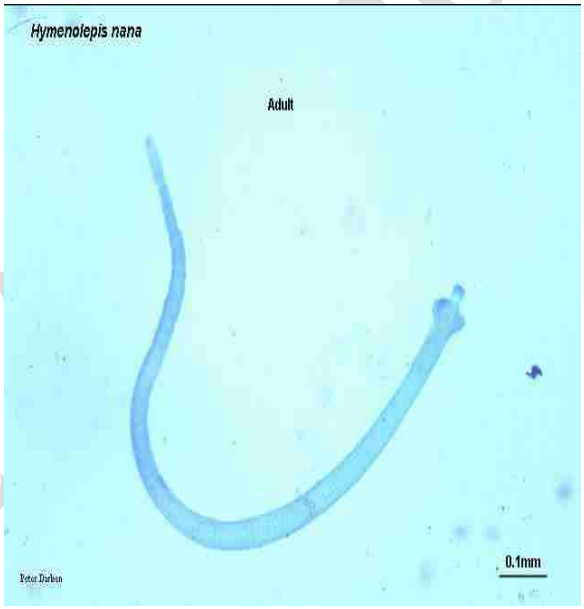
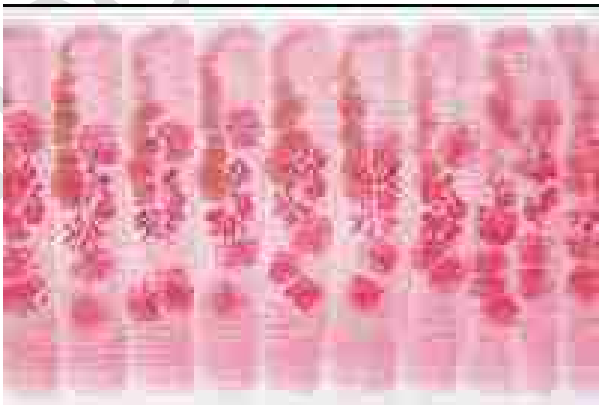
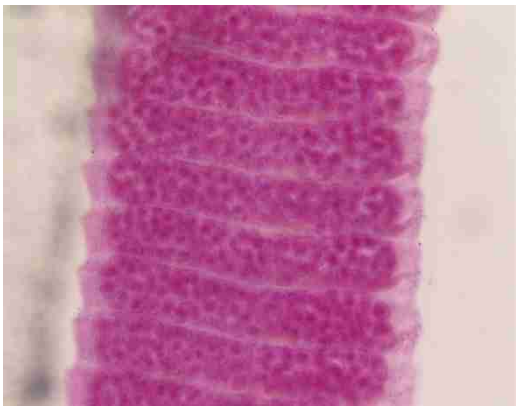




D. Ameera Al-Qadasi

- Gravid segment:
  - Brooder than long.
  - Uterus is transversely Lying sac full of eggs.



➢ **Egg:**

- Eggs are diagnostic and Infective stage.
- Size: 30 – 50 µm
- Shape: Spherical, thin shell with 2 coverings.
- Color: Translucent.
- Content: Hexacanth onchosphere (embryo).

D. Ameera Al-Qadasi

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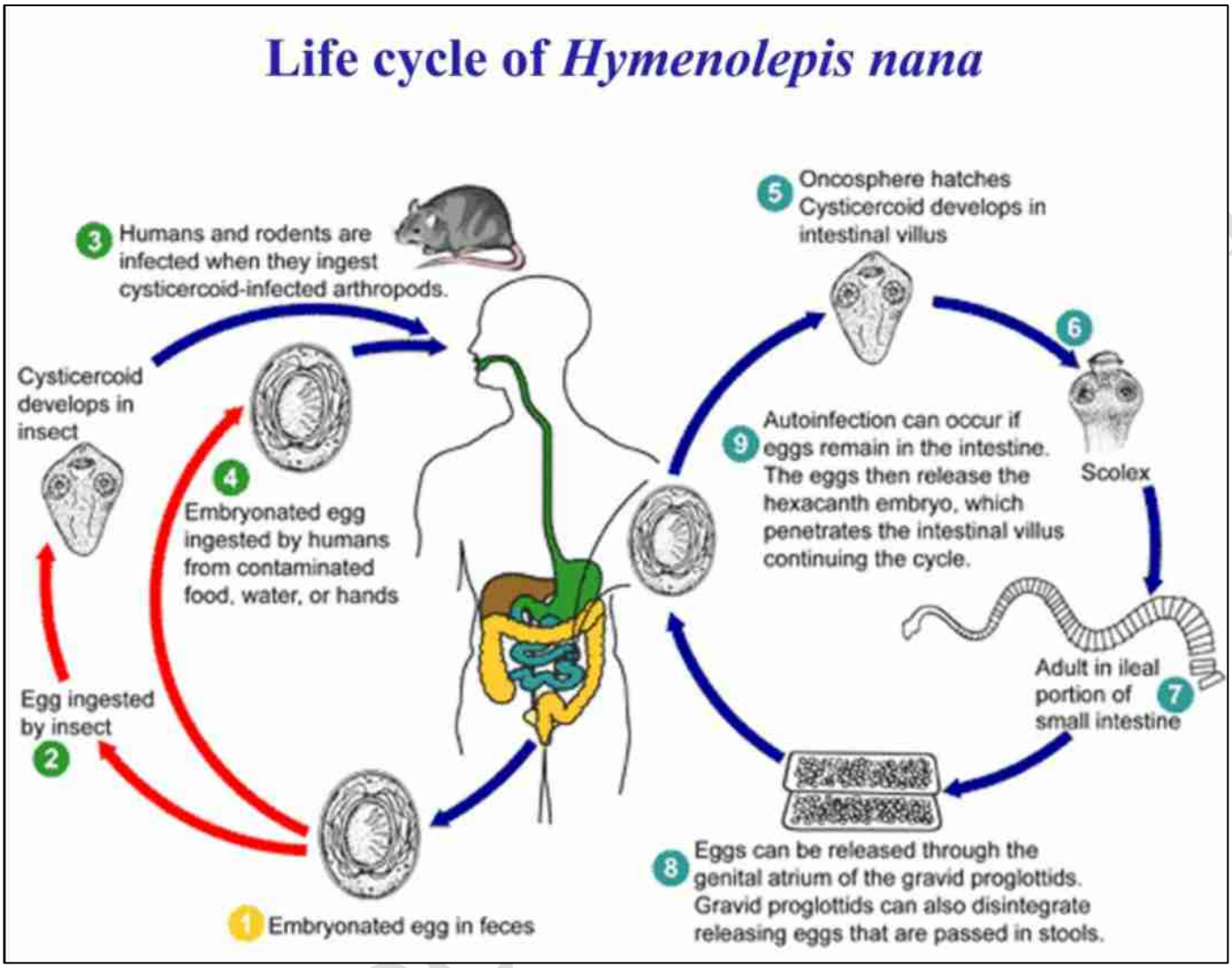
- **Life cycle**


Life cycle of Hymenolepis nana
5 Oncosphere hatches Cysticercoid develops in intestinal villus
3 Humans and rodents are infected when they ingest cysticercoid-infected arthropods.
Cysticercoid develops in insect
4 Embryonated egg ingested by humans from contaminated food, water, or hands
6
Scolex
9 Autoinfection can occur if eggs remain in the intestine. The eggs then release the hexacanth embryo, which penetrates the intestinal villus continuing the cycle.
Adult in ileal portion of small intestine 7
Egg ingested by insect 2
8 Eggs can be released through the genital atrium of the gravid proglottids. Gravid proglottids can also disintegrate releasing eggs that are passed in stools.
1 Embryonated egg in feces

D. Ameera

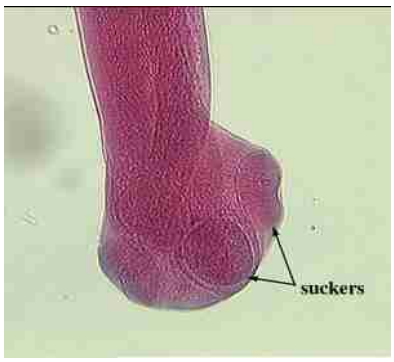
➢ *Hymenolepis diminuta*

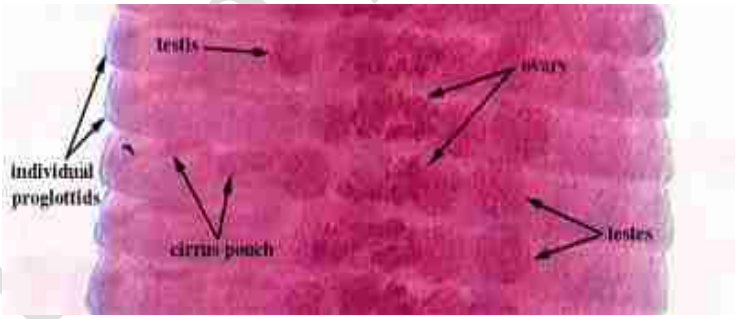
- **Scientific Classification**
  - Kingdom: Animal
  - Phylum: Platyhelminthes
  - Class: Cestoidea
  - Subclass: Cestoda
  - Order: Cyclophyllidea
  - Genus: *Hymenolepis*
  - Species: *Hymenolepis diminuta*.
- **Common name: The Rat Tapeworm**
- **Disease:**
  - Hymenolepiasis.
- **Habitat:**
  - The adults are found in the lumen of the upper three-quarters of the ileum.
- **Mode of infection:**
  - Ingestion of intermediate host containing larval stages.
- **Definitive host:**
  - Rats.
  - Dogs.
  - Humans.
- **Intermediate hosts:**
  - Grain beetle.
  - Lots of other arthropods (earwigs, larval fleas, various beetles).

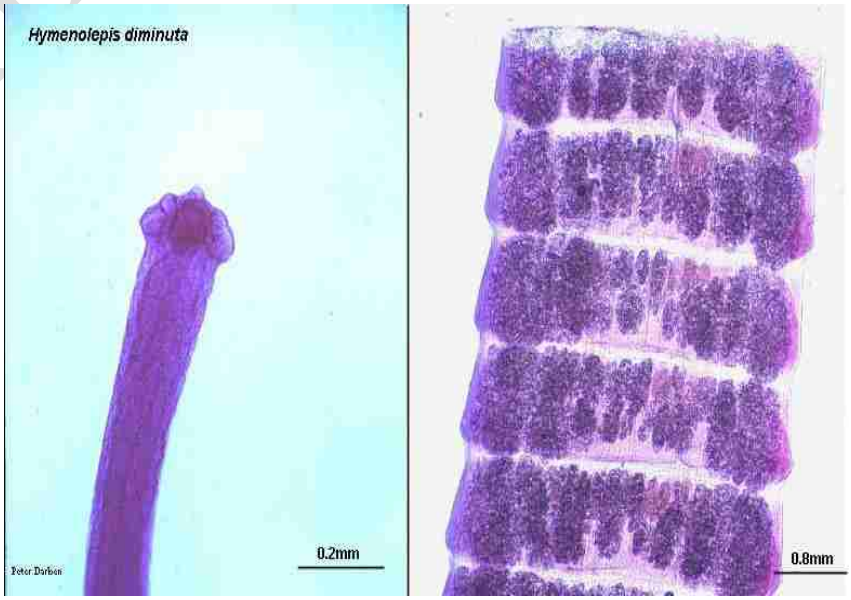
D. Ameera Al-Qadasi

- **Morphology**

  - Grows to be about 20 - 60cm or more in length.
  - Consists of up to 1000 proglottids that are approximately four times as wide as they are long.
  - Each proglottid contains three round testes, a bi-lobed ovary, a compact vitelline gland and a large uterus opening to a lateral genital pore.
  - The scolex has four suckers and a retractable rostellum that does not have hooks.
  - Eggs are larger at 60 - 80µm in diameter than *H. nana* eggs.

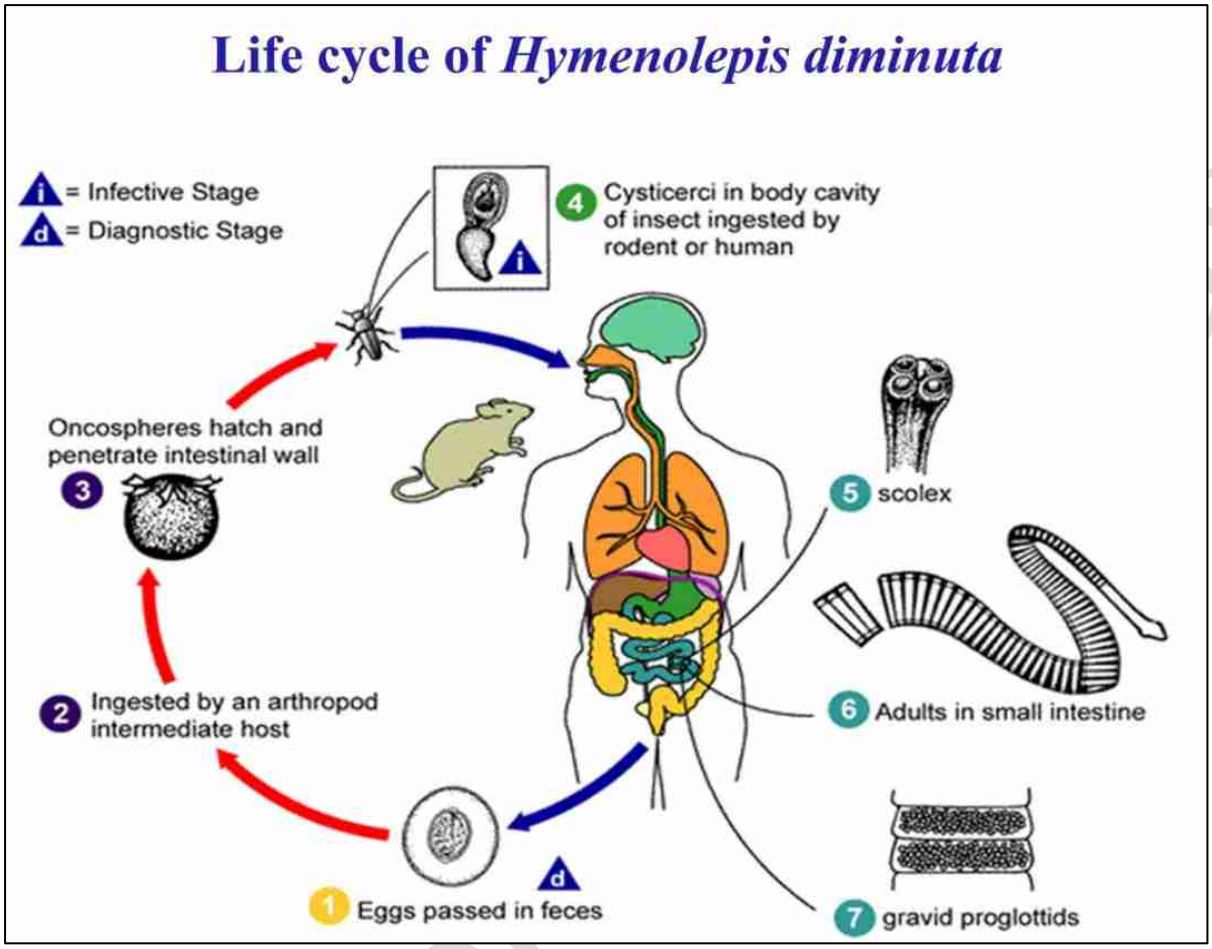






Hymenolepis diminuta
Egg
Peter Darben
10µm

- **Life cycle**


Life cycle of Hymenolepis diminuta
i = Infective Stage
d = Diagnostic Stage
4 Cysticerci in body cavity of insect ingested by rodent or human
Oncospheres hatch and penetrate intestinal wall
3
5 scolex
2 Ingested by an arthropod intermediate host
6 Adults in small intestine
1 Eggs passed in feces
7 gravid proglottids

D. Ameera Al-Qadasi

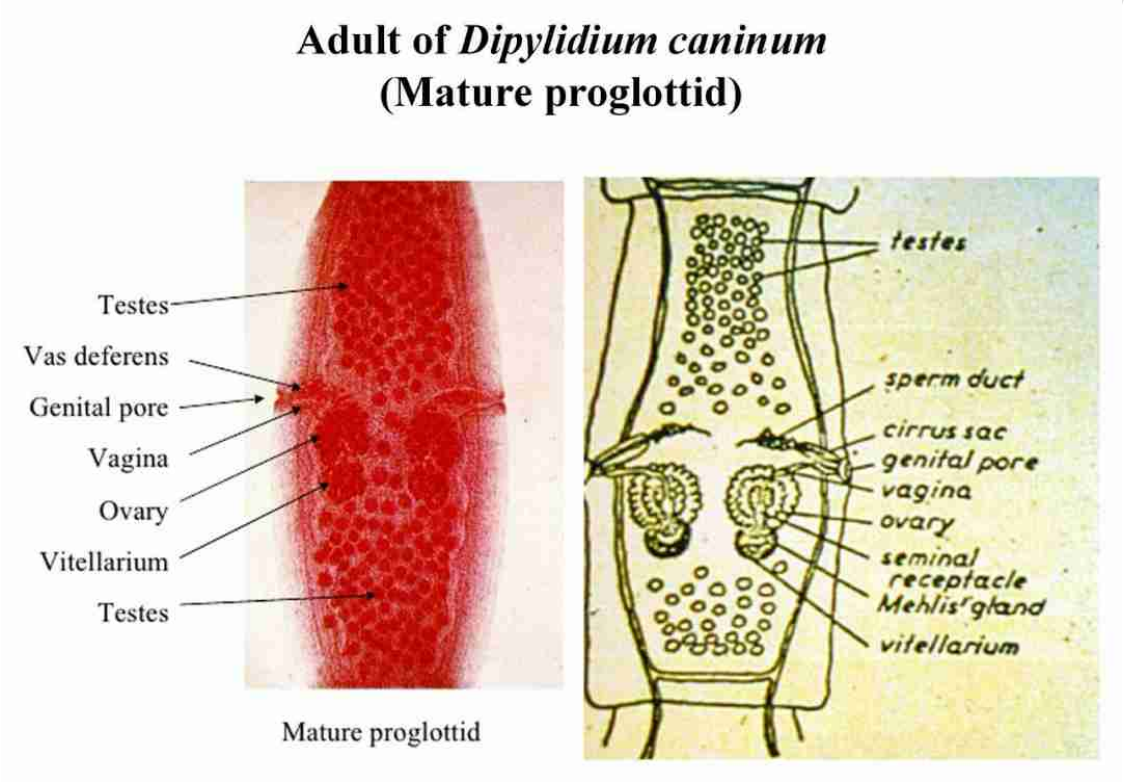
➢ *Dipylidium caninum*

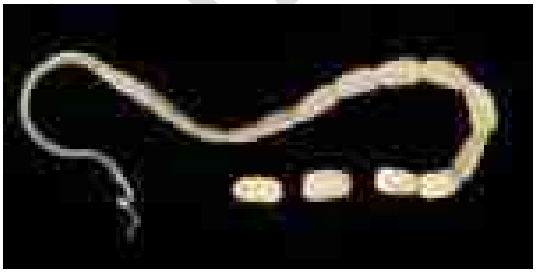
- **Scientific Classification**
  - Kingdom: Animal
  - Phylum: Platyhelminthes
  - Class: Cestoidea
  - Subclass: Cestoda
  - Genus: *Dipylidium*
  - Species: *Dipylidium caninum.*
- **Common name: The double-pored dog tapeworm, flea tapeworm** or **cucumber tapeworm**
- **Disease:**
  - Dipylidiasis
- **Habitat:**
  - In the small intestine of dog, cat and human.
- **Mode of infection:**
  - Eggs are ingested by fleas; larvae develop within fleas.
  - The definitive host is infected by ingestion of larvae within fleas.
  - The worm develops in the small intestine of the definitive host.
- **Definitive host:**
  - Dog, Cat and Human.
  - ***Note:*** *Dipylidium caninum* mainly infects dogs and cats, but is occasionally found in humans.
    - Rare in humans, occurring primarily in infants and small children closely associated with pets.
- **Intermediate hosts:**
  - Fleas of dog or cat.
- **Distribution**
  - Worldwide.

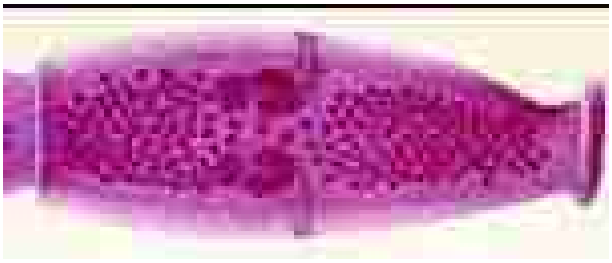
D. Ameera Al-Qadasi

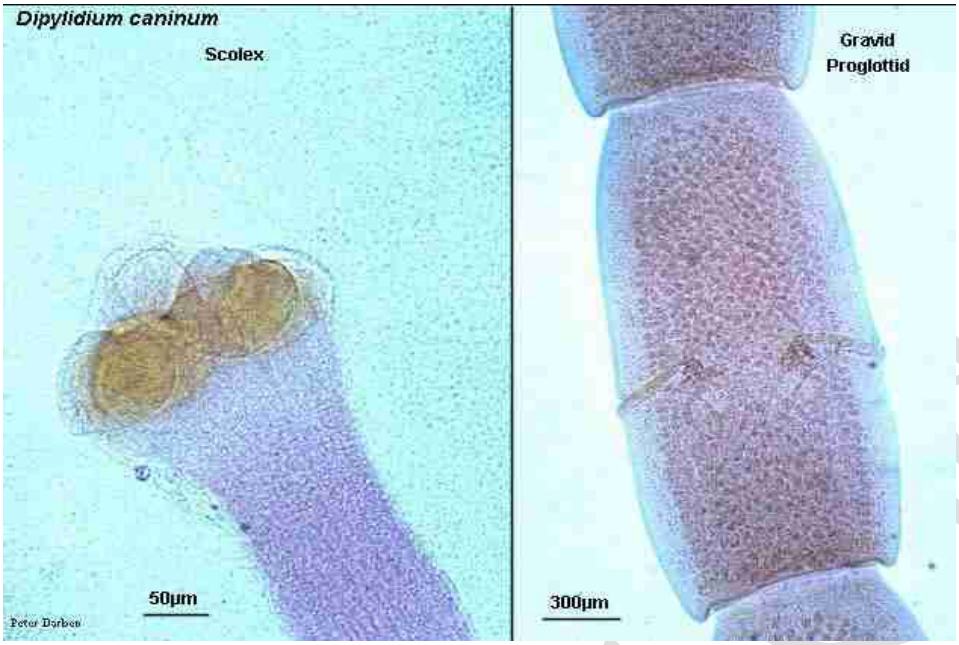
- **Morphology**

  - **Adult:** The adult is up to 70 centimeters in length.
    - Scolex: Armed rostellum; 4 sucking disks.
    - Gravid proglottids are the size of rice grains, and exhibit a genital pore on each side.







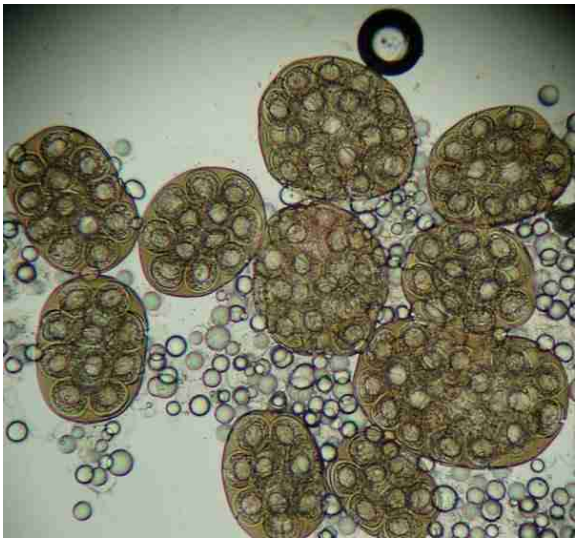


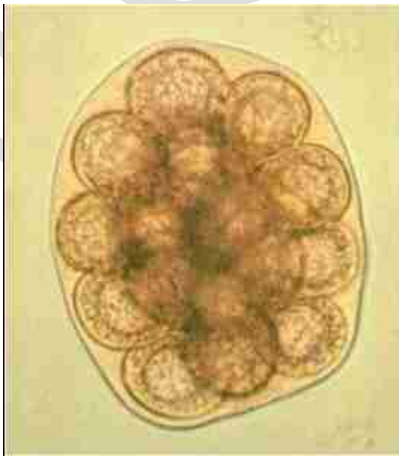
- **Eggs:** Contained within packets (up to 15 eggs/packet).

Egg Packet of *Dipylidium caninum*

Egg Packet: round to oval and containing 5-15 eggs

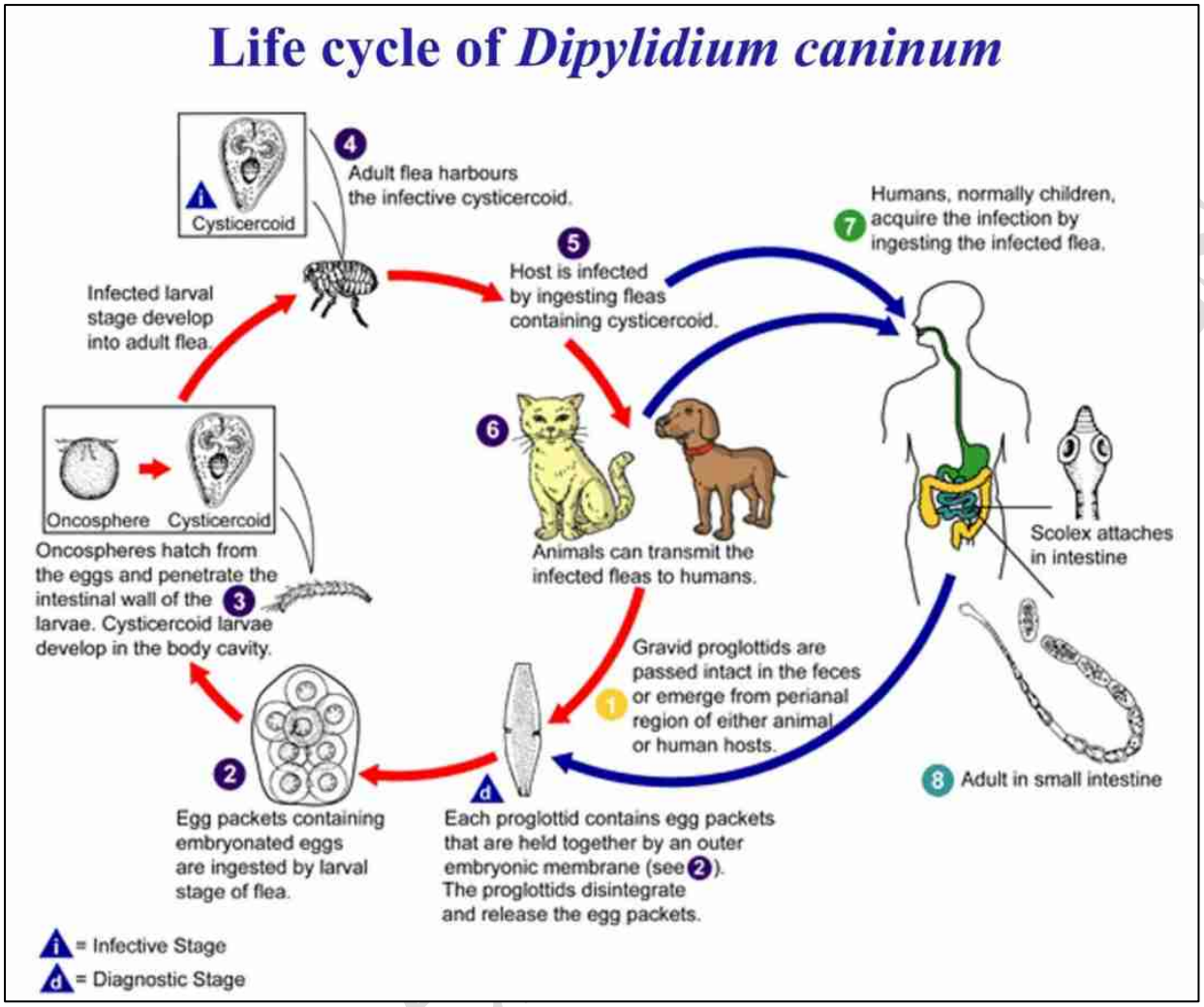
D. Ameera Al-Qadasi





D. Ameera Al-Qadasi

- **Life cycle**


Life cycle of Dipylidium caninum
Cysticercoid
4 Adult flea harbours the infective cysticercoid.
5 Host is infected by ingesting fleas containing cysticercoid.
7 Humans, normally children, acquire the infection by ingesting the infected flea.
Infected larval stage develop into adult flea.
Oncosphere
Cysticercoid
Oncospheres hatch from the eggs and penetrate the intestinal wall of the larvae. Cysticercoid larvae develop in the body cavity.
3
6
Animals can transmit the infected fleas to humans.
Scolex attaches in intestine
Gravid proglottids are passed intact in the feces or emerge from perianal region of either animal or human hosts.
1
2
Egg packets containing embryonated eggs are ingested by larval stage of flea.
d
Each proglottid contains egg packets that are held together by an outer embryonic membrane (see 2). The proglottids disintegrate and release the egg packets.
8 Adult in small intestine
i = Infective Stage
d = Diagnostic Stage

- **Diagnosis**

  - By finding proglottids contain egg packets in the feces.

D. Ameera Al-Qadasi

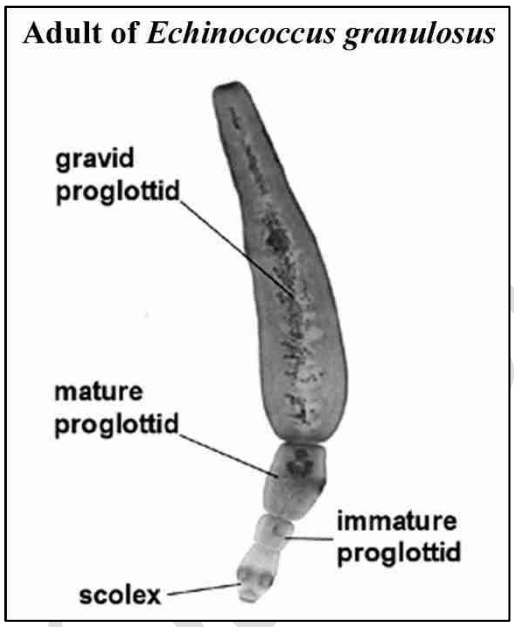
- **Systemic cestode**
  - ***Echinococcus granulosus***

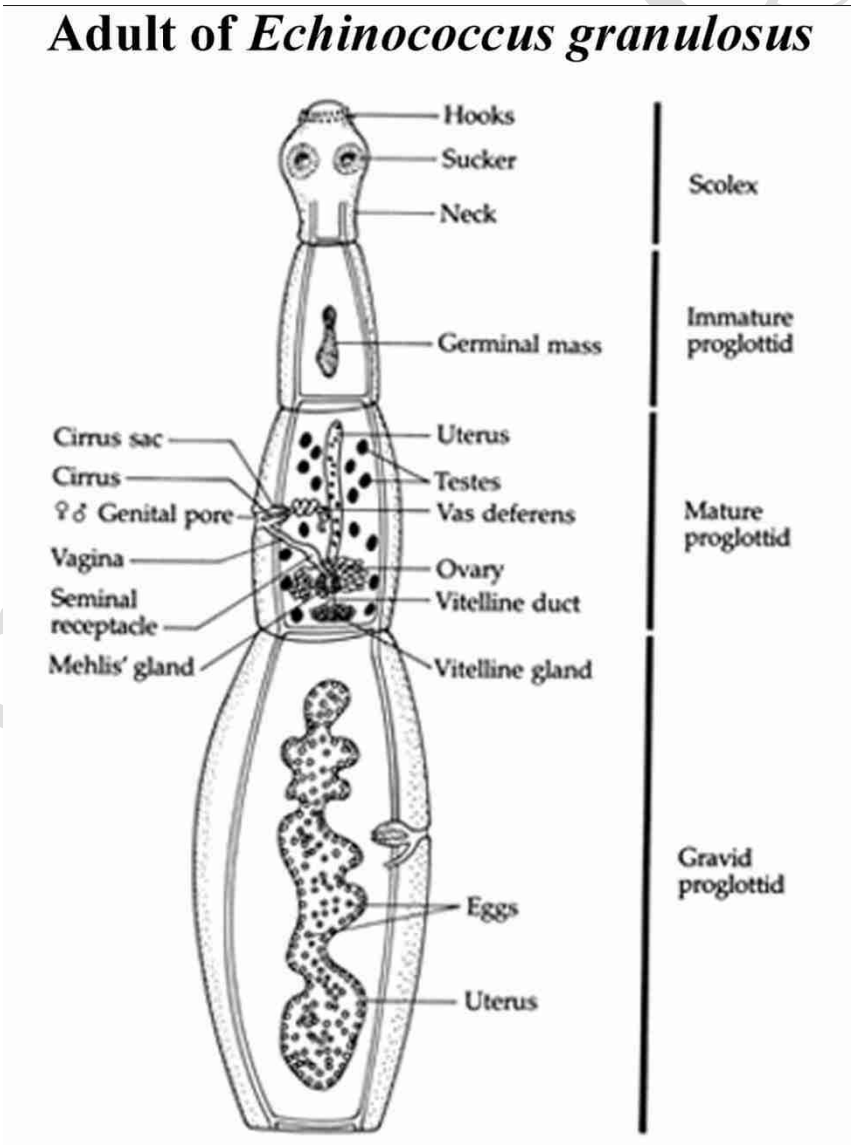
- **Scientific Classification**
  - Kingdom: Animal
  - Phylum: Platyhelminthes
  - Class: Cestoidea
  - Subclass: Cestoda
  - Order: Cyclophyllidea
  - Genus: *Echinococcus*
  - Species: *Echinococcus granulosus.*
- **Common name: Dog tape worm or The Hydatid Tapeworm**
- **Disease:**
  - Echinococcosis, also called hydatid disease, hydatidosis, or echinococcal disease.
- **Habitat:**
  - **Adult:** In small intestine of doges, foxes and wolves.
  - **Larva:** In intermediate host tissues (liver, lungs, abdominal cavity, spleen, kidneys, heart, bones, central nervous system etc.).
- **Mode of infection:**
  - Ingestion of eggs from soil, food or drinks contaminated with dog feces or from dog fur.
- **Definitive host:**
  - Carnivores as doges, foxes and wolves.
- **Intermediate hosts:**
  - Various herbivores as cattle, sheep.
  - Human can be a dead end intermediate host.

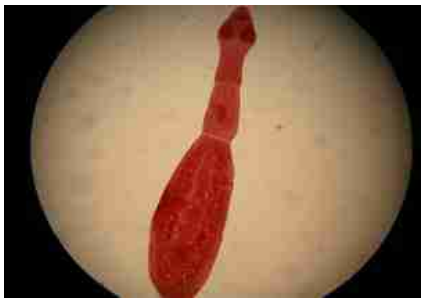
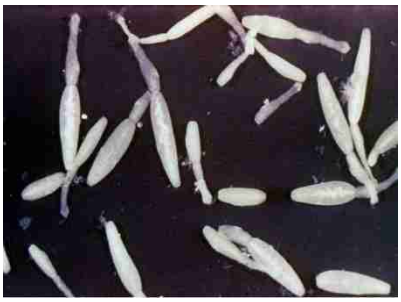
D. Ameera Al-Qadasi

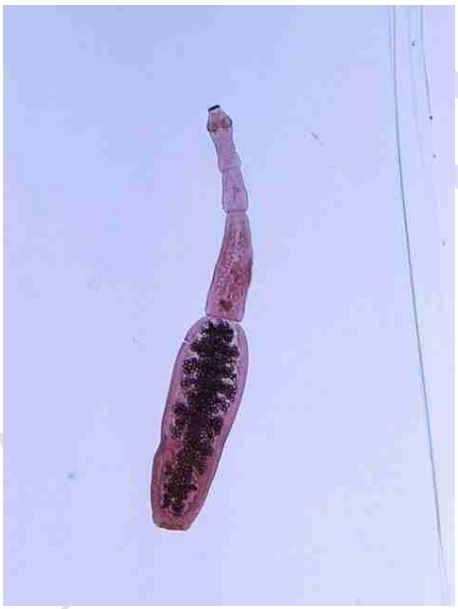
- **Morphology**

  - **Adult**:
    - It is the **smallest cestode**; composed only from 3 segments (proglottides) with head and neck.
    - Size: 3 – 6 mm
    - **Scolex**: Globular with 4 suckers and a double hook crowned rostellum.
    - The rest of the body (Strobila) consists of 3 proglottides.
    - Mature segment: longer than broad.
    - Gravid segment: Lateral pouches





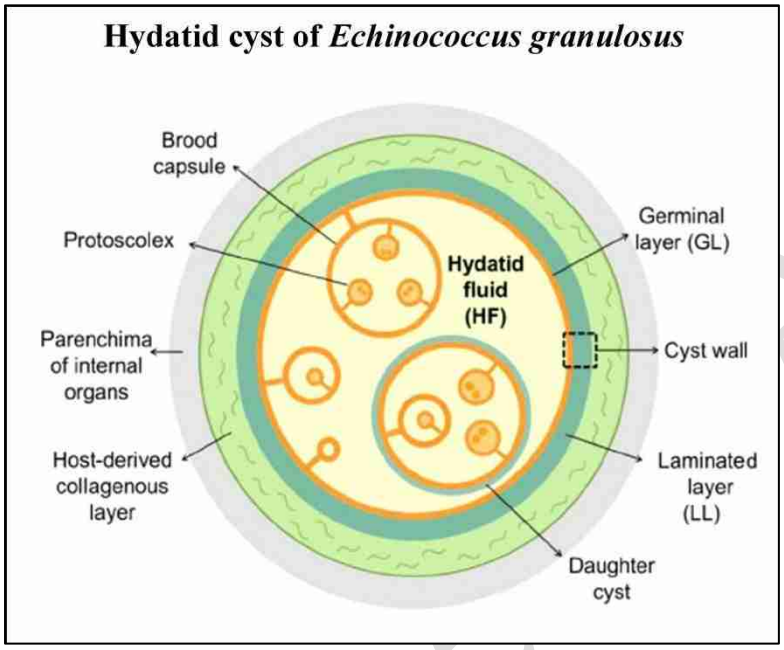



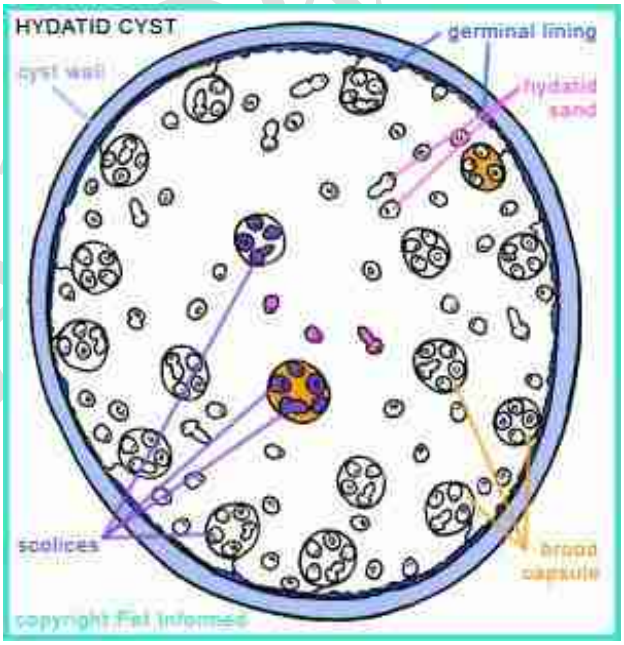


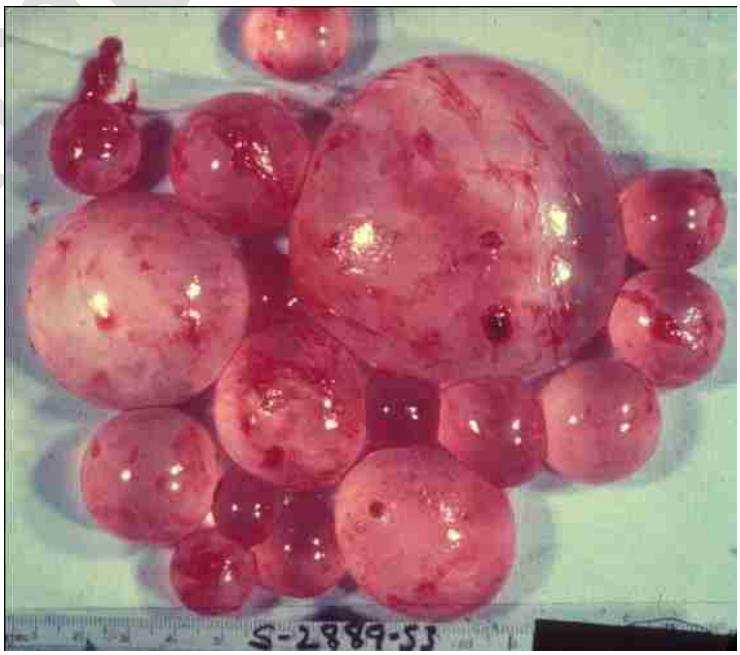
- **Egg:**
  - Similar to *Taenia* species eggs.

➢ Morphology of Hydatid cyst

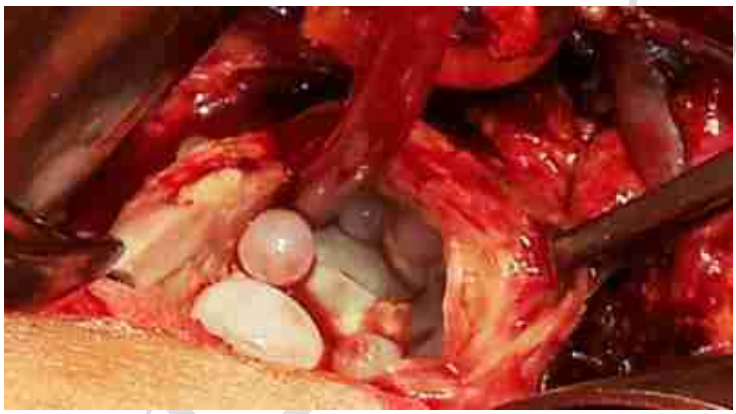
- Size: It reaches 10 cm or more (this takes many year).
- Shape: Spherical filled with fluid, and has three layers:
  1. Germinal layer (GL).
  2. Laminated layer (LL).
  3. Fibrous layer (FL).
- The cyst contains:
  - Individual scolices
  - Daughter cysts
  - Brood capsules
  - Hydatid sand



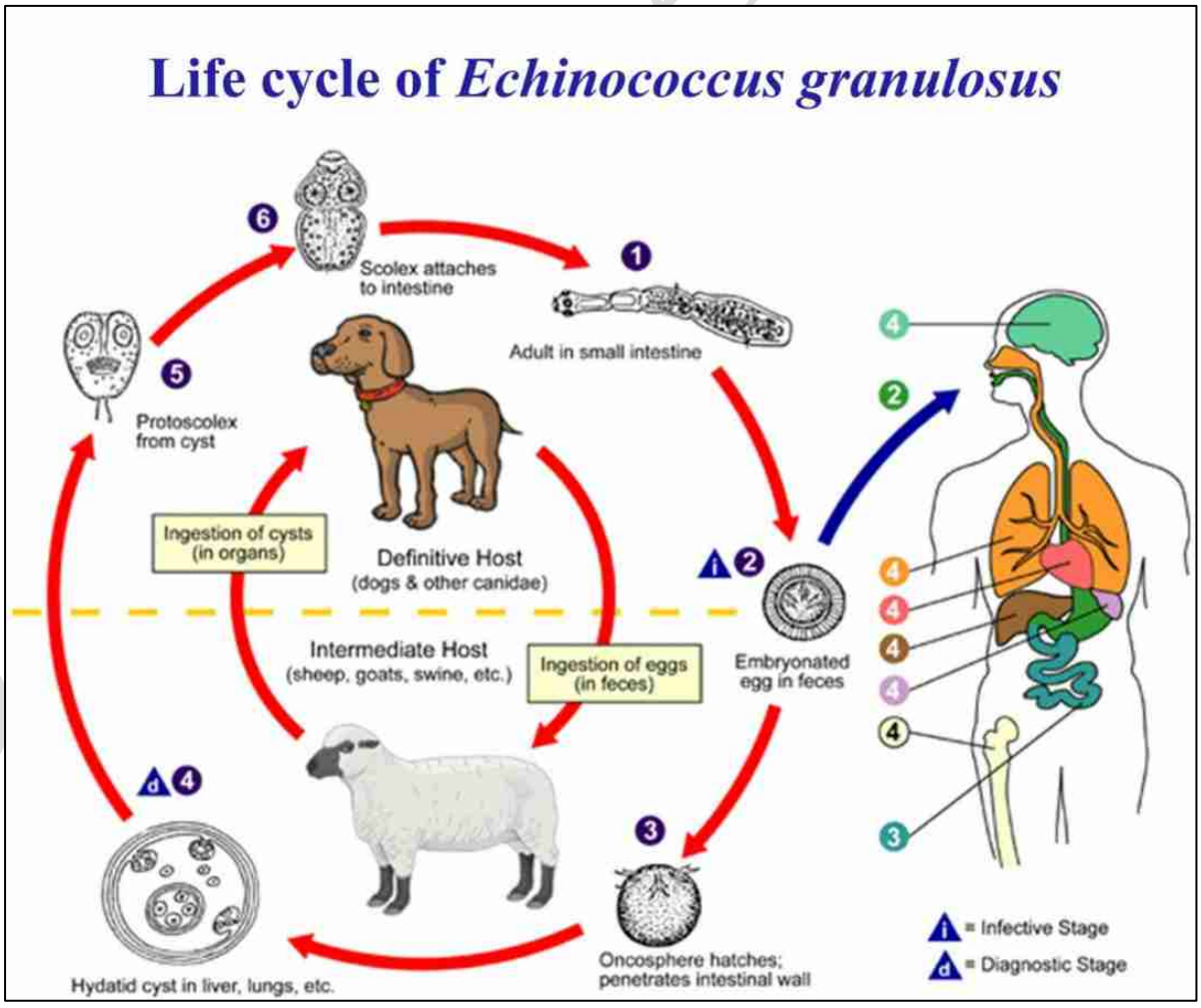




- Site of the Hydatid cyst inside the Human:
  - Hepatic cyst (66 %)
  - Pulmonary cyst (22 %)
  - Brain cyst (about 1 %)
  - Renal cyst (about 3 %)
  - Osseous cyst (about 2 %)



- **Life cycle**


Life cycle of *Echinococcus granulosus*
Scolex attaches to intestine
Adult in small intestine
Protoscolex from cyst
Ingestion of cysts (in organs)
Definitive Host (dogs & other canidae)
Intermediate Host (sheep, goats, swine, etc.)
Ingestion of eggs (in feces)
Embryonated egg in feces
Oncosphere hatches; penetrates intestinal wall
Hydatid cyst in liver, lungs, etc.
i = Infective Stage
d = Diagnostic Stage

- **Diagnosis**

  - Hydatid phase.
  - The diagnosis of echinococcosis relies mainly on findings by ultrasonography and/or other imaging techniques supported by positive serologic tests.
  - Imaging techniques that used to detect cysts, such as:
    - CT scans.
    - Ultrasonography.
    - MRIs.
  - After a cyst has been detected, serologic tests may be used to confirm the diagnosis.

- **Infective Stage for human:**

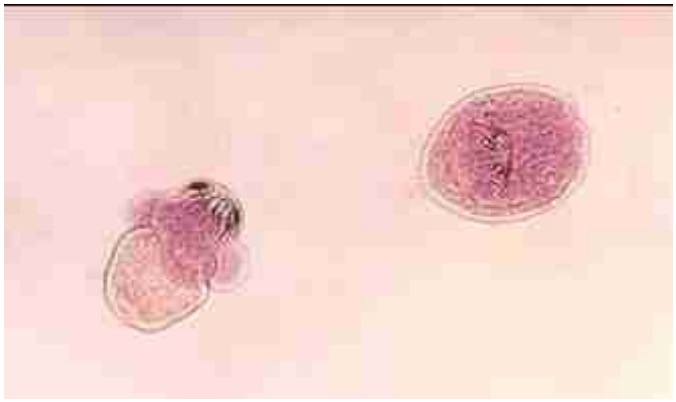
  - Ingestion of eggs through:
  - Hand to mouth from fur of infected dogs while playing with dogs.
  - Food or drink contaminated with faeces of infected dogs.

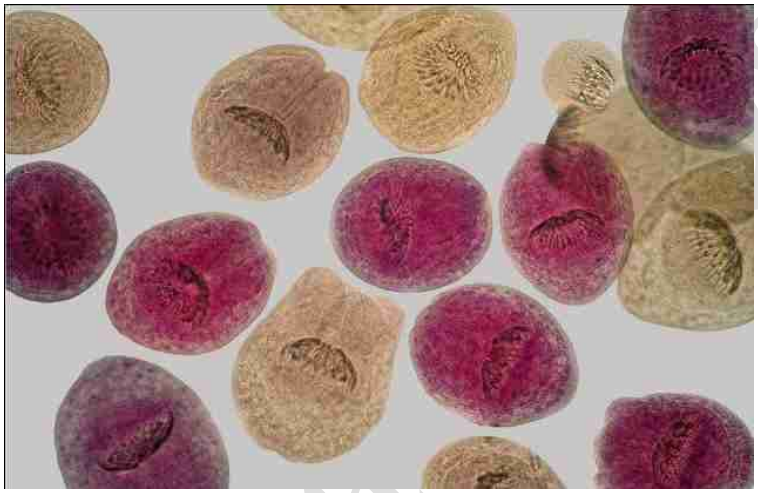
- **Infective Stage for dogs:**

  - Protoscolices (Eating of viscera of intermediate host where scolices develop into adults).

D. Ameera Al-Qadasi

- **Evaginated and Invaginated Scolices of *Echinococcus granulosus***





D. Ameera Al-Qadasi

3. Nematode (Round-worms)

- **General characters of Nematode**
  1. Round-worms are unsegmented, long, cylindrical worms that taper at each end.
  2. Have a body cavity containing body fluid with digestive and reproductive systems.
  3. Possess complete digestive tracts.
  4. Have a protective outer cuticle.
  5. Number of reproduction strategies:
     a. Intestinal nematodes shed eggs into lumen of the intestine.
        – Eggs are consumed in contaminated food or water.
     b. Larvae of some intestinal nematodes hatch in the soil.
        – Larvae actively penetrate the skin of a host.
     c. Some nematodes encyst in muscle tissue.
        – Consumed in raw or undercooked meat.
     d. Mosquitoes transmit a few species of filarial nematodes.
  6. Adult sexually mature stages are found only in definitive hosts.
  7. All nematode parasites are dioecious (separate sexes):
     - **Male**:
       - In general, smaller than female.
       - With curved posterior end.
     - **Female**:
       - In general, larger in size.
       - With straight posterior end.

D. Ameera Al-Qadasi

- **Scientific Nomenclature**
  - Kingdom: Animal
  - Phylum: Nemathelminth
  - Class: Nematoda (Round Worm)

- **Classification of Nematode according to habitat:**

1. **Intestinal nematodes:**
   i. *Ascaris lumbricoides* (Large round-worm)
   ii. *Trichuris trichiura* (Whip-worm)
   iii. *Enterobius vermicularis* (Pin-worm)
   iv. *Ancylostoma duodenale* and *Necator americanes* (Hook-worm)
   v. *Strongyloides stercoralis*.
   vi. *Trichinella spiralis* (Trichinosis)
2. **Tissue nematodes:**
   i. *Wuchereria bancrofti*
   ii. *Loa loa*
   iii. *Onchocercerca volvus*

D. Ameera Al-Qadasi

1. **Intestinal nematodes:**

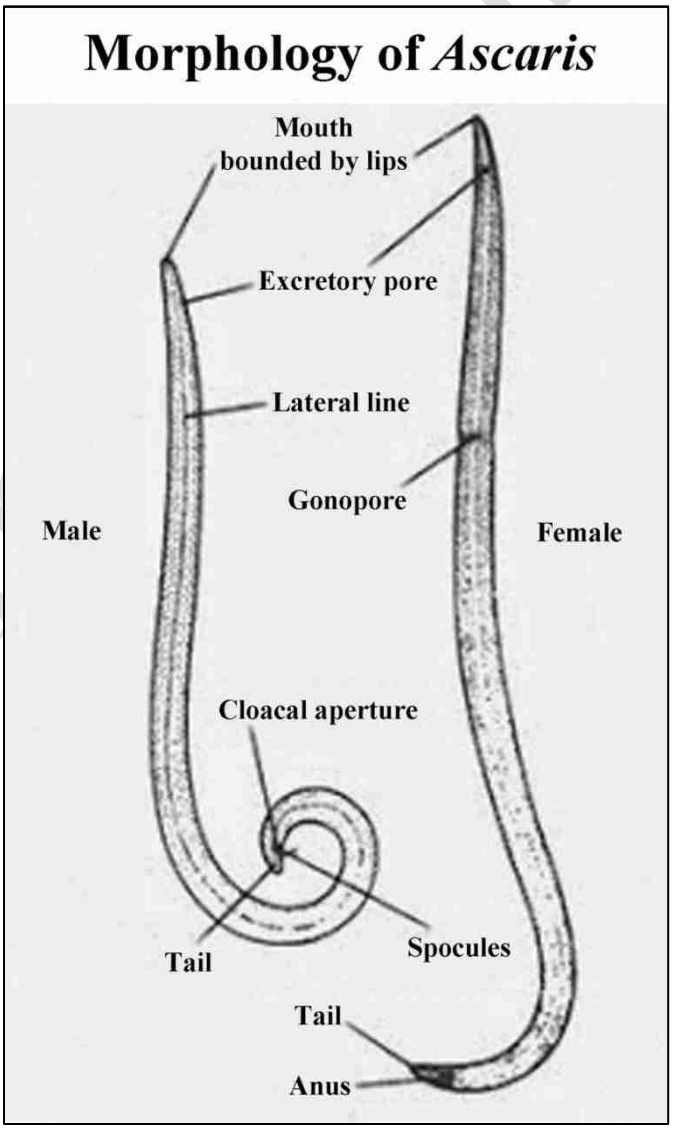
   - ***Ascaris lumbricoides***

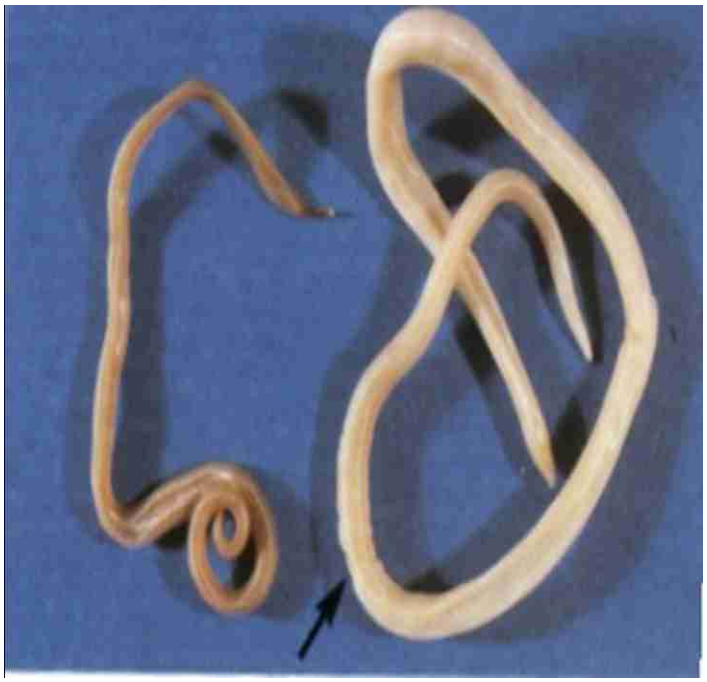
- **Scientific Classification**
  - Kingdom: Animal
  - Phylum: Nemathelminth
  - Class: Nematoda
  - Genus: *Ascaris*
  - Species: *Ascaris lumbricoides*.
- **Common name: Large round-worm**
  - largest of the intestinal nematodes parasitizing humans.
- **Disease:**
  - **Ascariasis**, a type of helminthiasis and one of the group of neglected tropical diseases.
- **Distribution:**
  - Worldwide, especially in tropical and subtropical countries.
- **Habitat:**
  - The lumen of small intestine (Free).
- **Mode of infection:**
  - Ingestion of embryonated eggs with:
    - Raw vegetables or water.
    - From contaminated hands by polluted soil.
  - Occasionally inhalation of contaminated dust.
- **Definitive host:**
  - Humans and pigs.
- **Intermediate hosts:**
  - None.

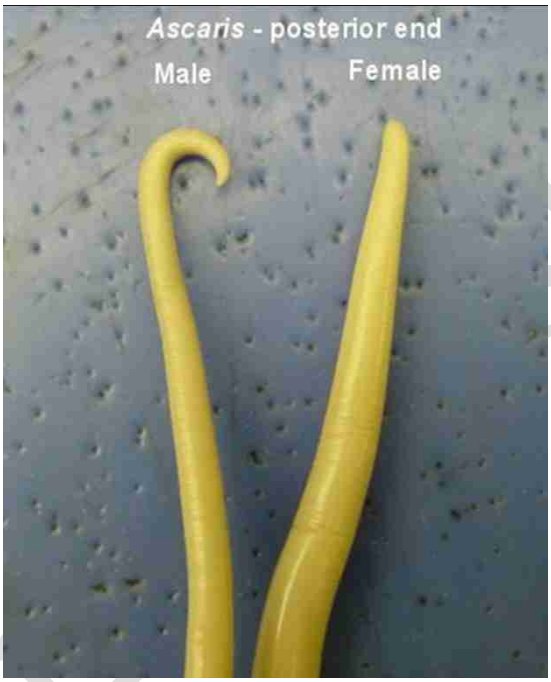
D. Ameera Al-Qadasi

- **Morphology**

  - **Adult:**
    - Cylindrical in shape (rounded in cross section).
    - Creamy-white or pinkish in color.
    - Long with tapering end.
    - On the tip of the head there are three lips, arranged as a Chinese word "品".
  - **The female:**
    - Size: 20-35cm in length (the largest 49cm)
    - With straight posterior end.
  - **The male :**
    - Size: 15-25cm in length.
    - Smaller than female and distinctly more slender than female.
    - With curved posterior end and it has 2 copulatory spicules.







- The three lips are seen at the anterior end.

D. Ameera Al-Qadasi

➢ **Egg:**

- A female may produce approximately 200,000 eggs per day.
- There are three kinds of the eggs:
  a) Unfertilized eggs.
  b) Fertileized eggs.
  c) Decorticated eggs.
- We usually describe an egg in 5 aspects:
  1. Size.
  2. Color.
  3. Shape.
  4. Shell.
  5. Content.

a) Unfertilized egg:

- It is not infective.
- Size: 90× 40µm.
- Shape: Longer and narrow.
- Embryo: Unembryonated.
- Color: Dark brownish in color.
- Shell: Thick and consists of mammillated albuminous coat.
- Content: Unfertilized ovum (Yolk cell) [A central mass of large granules (amorphous mass)].

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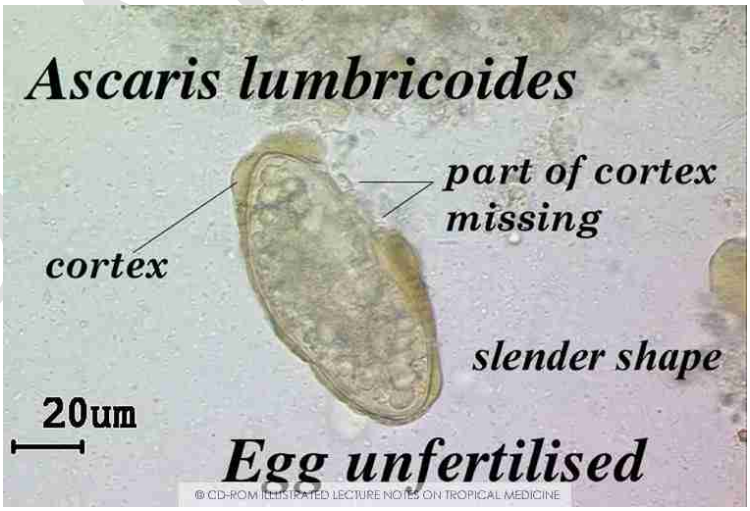

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b) Fertilized eggs:

- It is infective.
- Size: 60× 45µm.
- Shape: Spherical.
- Embryo: Developed unicellular embryo (Embryonated Egg).
- Color: Light brown in color.
- Shell: Thicker and consists of mammillated albuminous coat.
- Content: A fertilized ovum (Zygote).

- A fertilized *Ascaris* egg, still at the unicellular stage, as they are when passed in stool.

[redacted]

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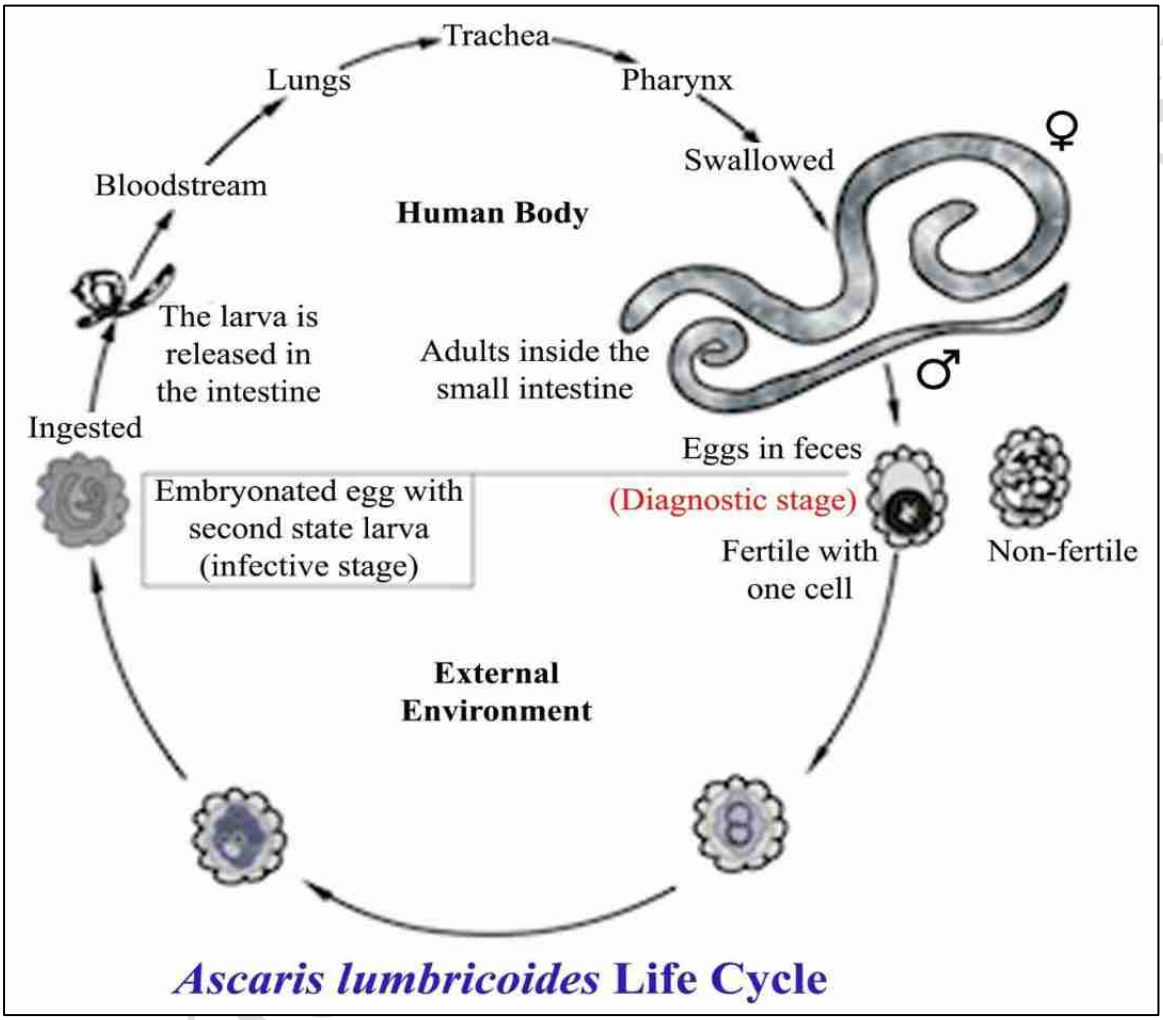
c) Decorticated eggs:

- Size: 60 µm.
- Shape: Spherical.
- Color: Light brown in color.
- Shell: No mammillated layer.
- Content: Fertilized ovum (Zygote).

- **Infective stage:**
  - Embryonated egg.
- **Diagnosis**
  - By finding eggs in the feces.

D. Ameera Al-Qadasi

- **Life cycle**
  - Infections with these parasites are more common where sanitation is poor, and raw human feces are used as fertilizer.



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➢ *Trichuris trichiura*

- **Common name: The whip-worm.**
- **Scientific Classification**
  - Kingdom: Animal
  - Phylum: Nemathelminth
  - Class: Nematoda
  - Genus: *Trichuris*
  - Species: *Trichuris trichiura*.
- **Disease:**
  - It causes **trichuriasis**; a type of helminthiasis which is one of the neglected tropical diseases).
- **Distribution**:
  - Worldwide.
- **Habitat:**
  - Large intestine in the caecum and appendix of human.
- **Mode of infection:**
  - Ingestion of embryonated eggs with:
    - Raw vegetables, fruits, or water.
    - From contaminated hands by polluted soil.
- **Definitive host:**
  - Humans.
- **Intermediate hosts:**
  - None.

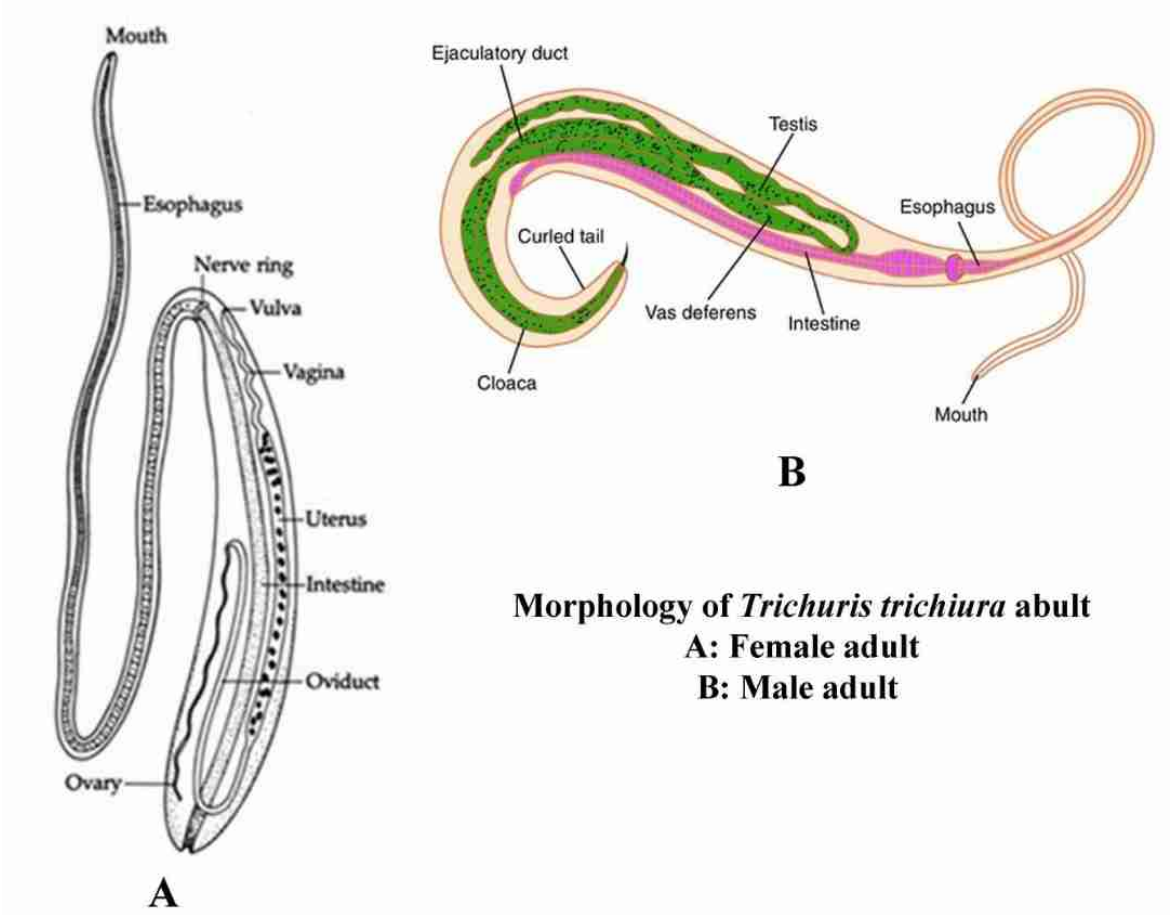
D. Ameera Al-Qadasi

- **Morphology**

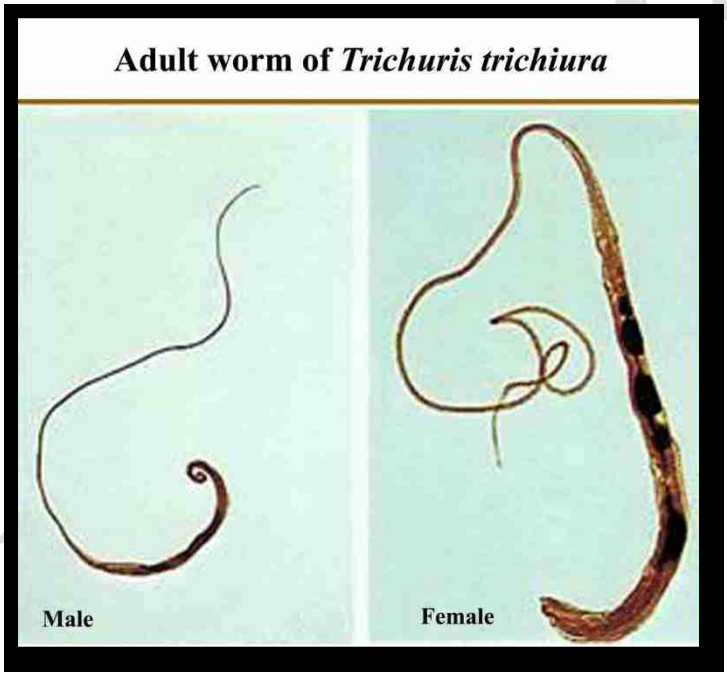
  - **Adult:**
    - The anterior 3/5 is thin and the posterior 2/5 is thick (Whip-shape).
    - Acellular oesophagus occupies the anterior thin portion.
    - Color: it is pinkish gray in color.
  - **The male :**
    - Size: 3 – 4 cm in length.
    - With curved posterior end.
    - It has single copulatory spicules inside a retractile sheath.
  - **The female:**
    - Size: 4 – 5 cm in length.
    - With straight blunt posterior end.

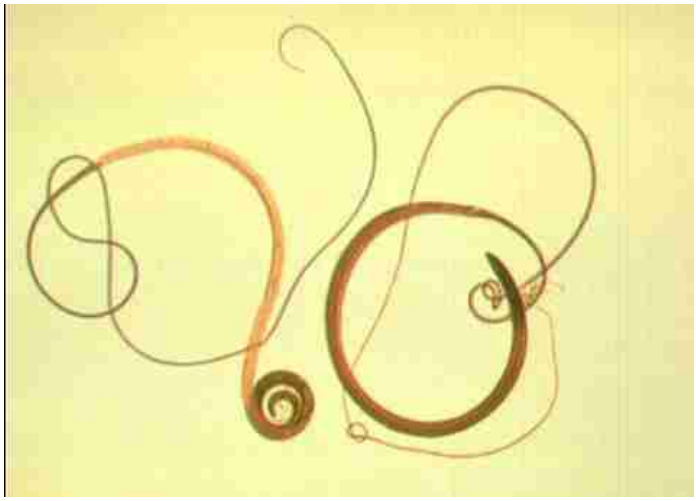
Morphology of *Trichuris trichiura* adult

D. Ameera Al-Qadasi



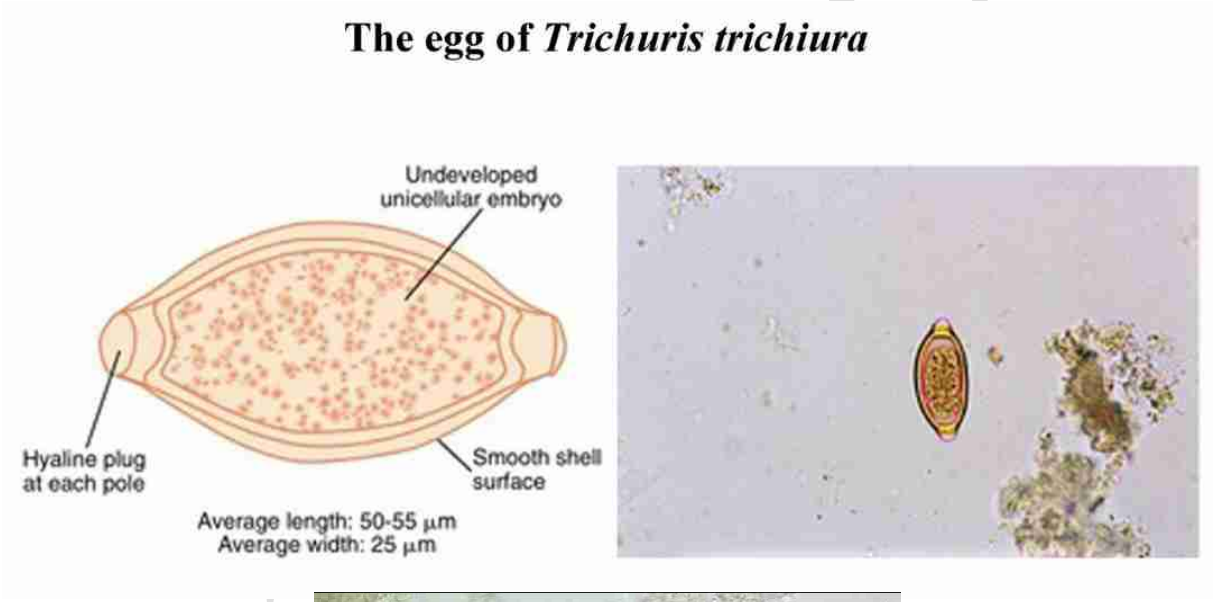
Morphology of *Trichuris trichiura* abult
A: Female adult
B: Male adult

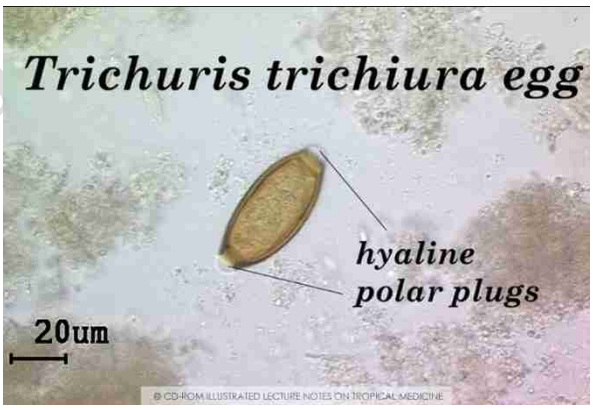


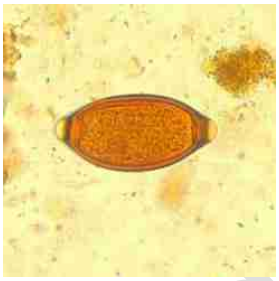


➢ **Egg:**

- A female may produce 2,000-10,000 single-celled eggs per day.
- Size: 50 X 25µm.
- Shape: Barrel –shaped.
- Shell: Thick transparent inner membrane with a mucoid plug at each pole.
- Color: Golden brown.
- Content: Immature ovum (one cell stage).


The egg of *Trichuris trichiura*
Undeveloped unicellular embryo
Hyaline plug at each pole
Smooth shell surface
Average length: 50-55 µm
Average width: 25 µm





- **Infective stage:**
  - Embryonated egg.
- **Diagnosis**
  - By finding eggs in the feces.

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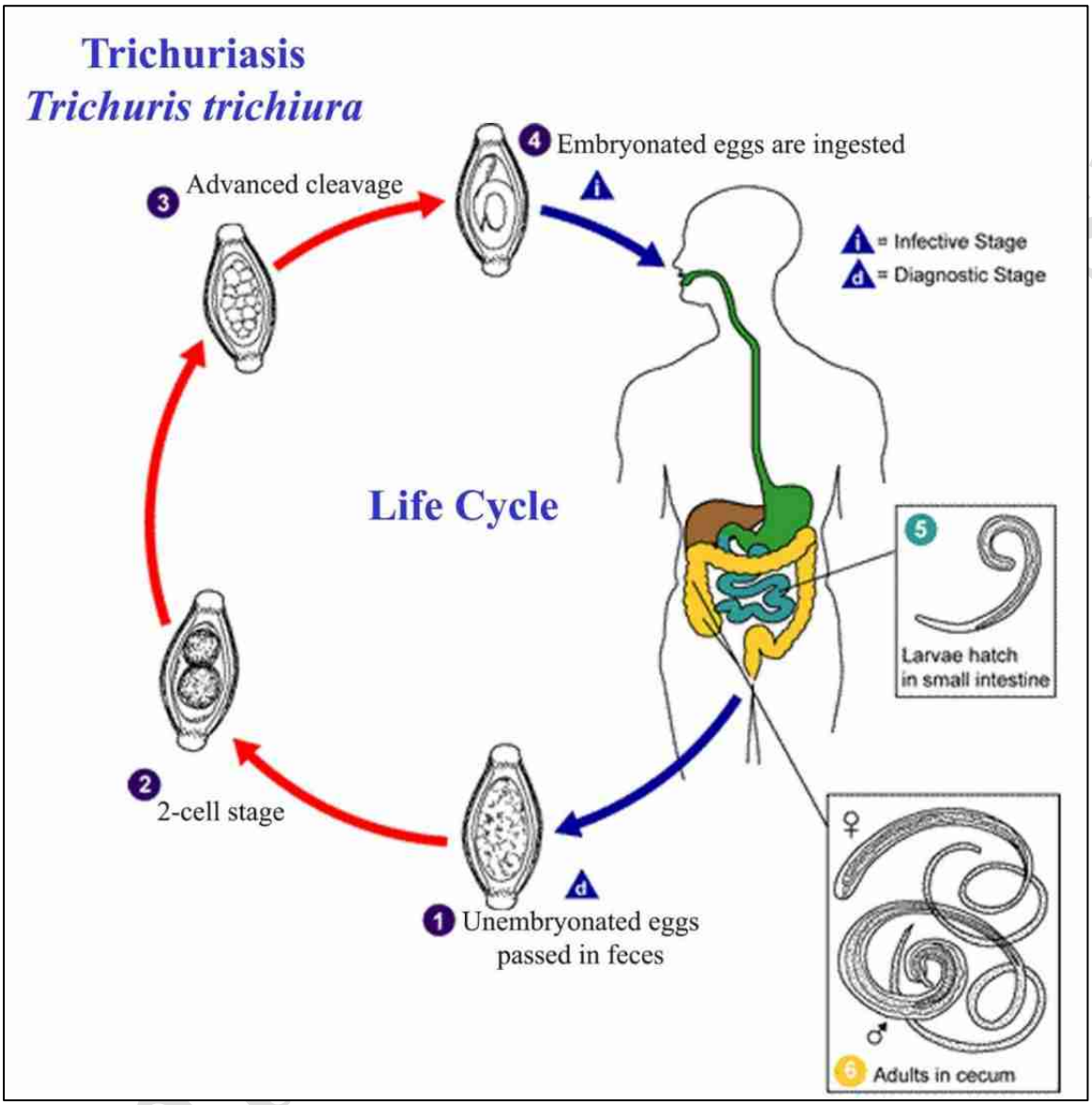
- **Life cycle**:


Trichuriasis
Trichuris trichiura
4 Embryonated eggs are ingested
3 Advanced cleavage
i = Infective Stage
d = Diagnostic Stage
Life Cycle
5
Larvae hatch
in small intestine
2
2-cell stage
1 Unembryonated eggs
passed in feces
6 Adults in cecum

➢ *Enterobius vermicularis*

- **Common names: Pin worm, Thread worm and Seat worm.**
- **Scientific Classification**
  - Kingdom: Animal
  - Phylum: Nemathelminth
  - Class: Nematoda
  - Genus: *Enterobius*
  - Species: *Enterobius vermicularis*.

- **Disease:**
  - Enterobiasis; Oxyuriasis (pruritus ani).
- **Distribution:**
  - Worldwide.
- **Habitat:**
  - Large Intestine:
    - Caecum.
    - Appendix.
    - Ascending colon.
- **Mode of infection:**
  - Fecal-oral transmission as following:
    - Ingestion of embryonated eggs with:
      - Autoinfectin.
      - Food and drink.
      - Hand to mouth after handling with contaminated clothes or bedding.
      - Retroinfection.
- **Definitive host:**
  - Human.
- **Intermediate hosts:**
  - None.

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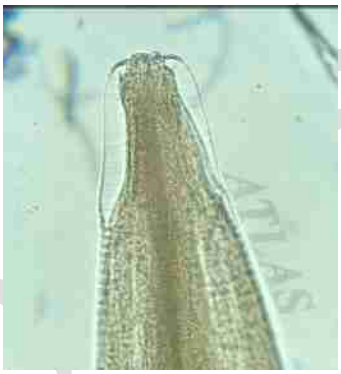
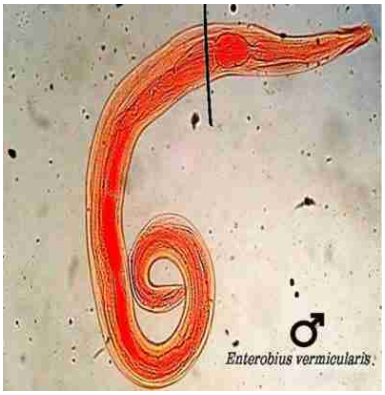
- **Morphology**

  - **Adult:**
    - Short, spindle – shaped worm (fusiform).
    - White in colour.
    - Pointed ends.
    - Resemble white threads
    - Oesophagus (double bulbed)
    - Cervical Alae:
      - At the anterior end.
      - Two in number.
      - Wing like cuticular expansions.
      - Transversely striated.



- **The male :**
  - Size: 2-5 mm.
  - Posterior end is curved with sub-terminal single copulatory spicule.
  - Thickness: 0.1- 0.2 mm.
  - Life span: 7 weeks.



- **The female:**
  - Size: 8 - 13 mm.
  - Long, thin, pointed, pin like tail.
  - Thickness: 0.3 - 0.5 mm.
  - Reproductive organs:
    - T shaped.
    - Paired.
  - Life span: 5 - 13 weeks.

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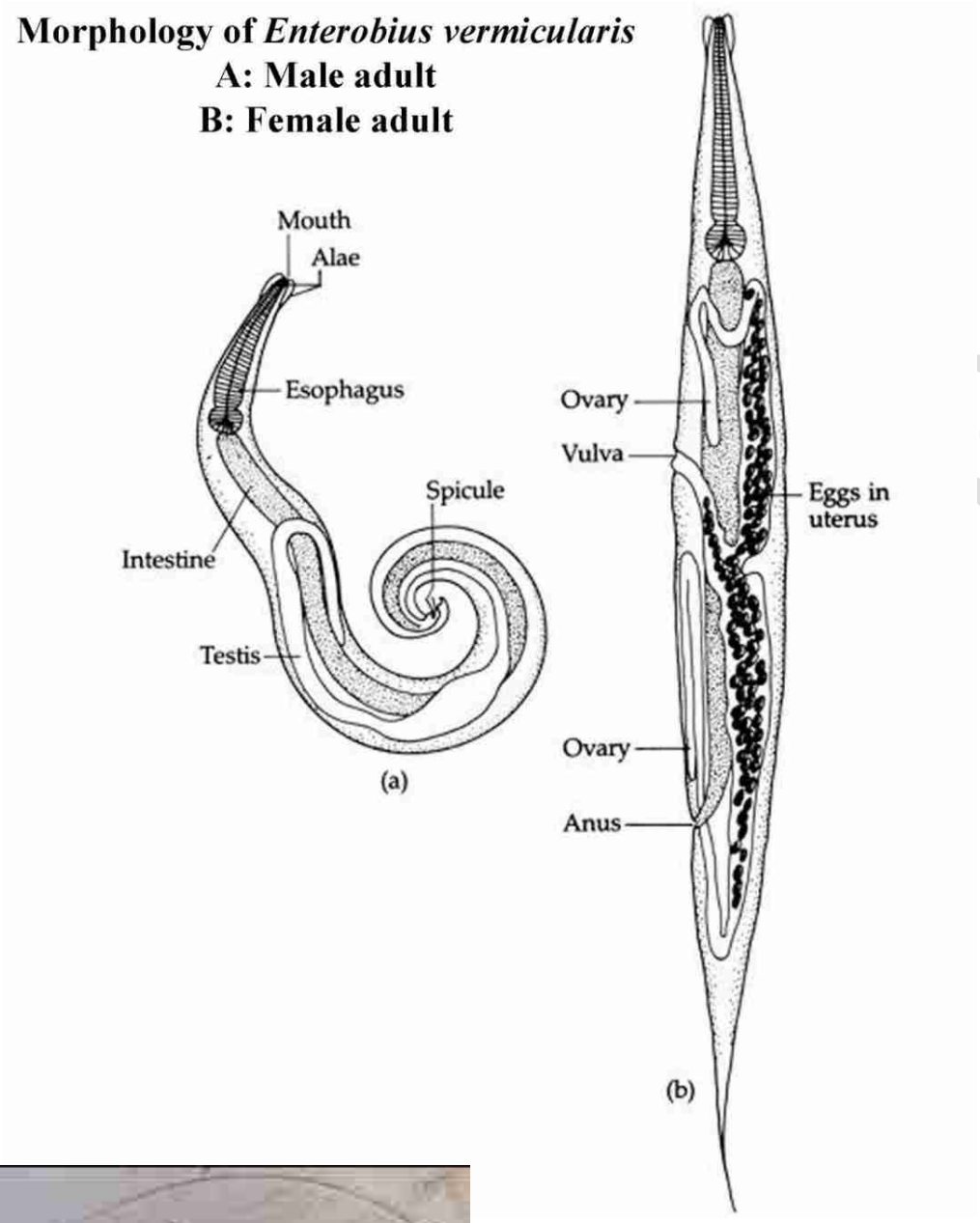
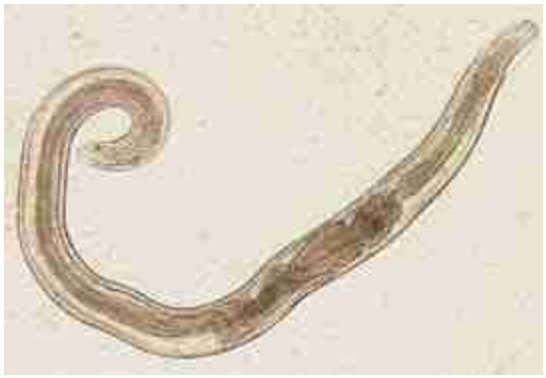

Morphology of *Enterobius vermicularis*
A: Male adult
B: Female adult
Mouth
Alae
Esophagus
Spicule
Intestine
Testis
(a)
Ovary
Vulva
Eggs in uterus
Ovary
Anus
(b)

Female



Male

➢ **Egg:**

- A female may produce 11,000-16,000 eggs.
- Size: 50x20 μm.
- Colourless, non-bile stained (translucent).
- Shape: Plano-convex (D-shaped).
- Shell: Double layered Transparent.
- Sticky outer albuminous layer.
- Contains 'tadpole shaped', coiled larva (mature).
- Viable up to 2 weeks.

▪ **Diagnostic stage:**

- Egg and adult.

▪ **Diagnosis**

- Demonstration of Adult worm:
  - On the surface of stool sample.
  - On the perianal skin.
  - In the stool after an enema.
- Demonstration of Eggs:
  - As they are seldom excreted in faeces.
  - Stool sample is not useful for diagnosis.

▪ **Infective stage:**

- Embryonated egg.

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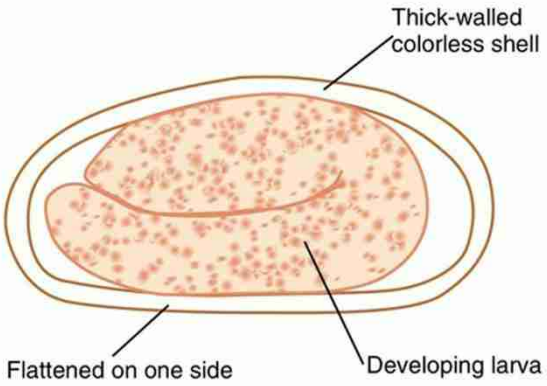
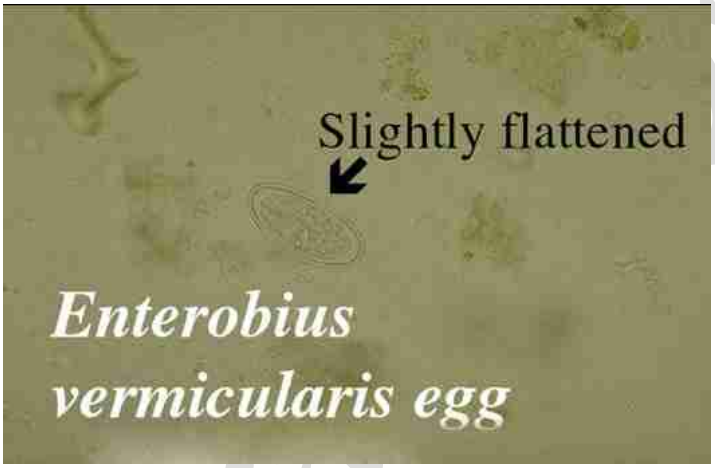
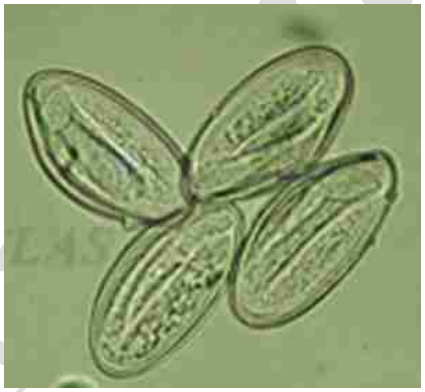
The egg of *Enterobius vermicularis*

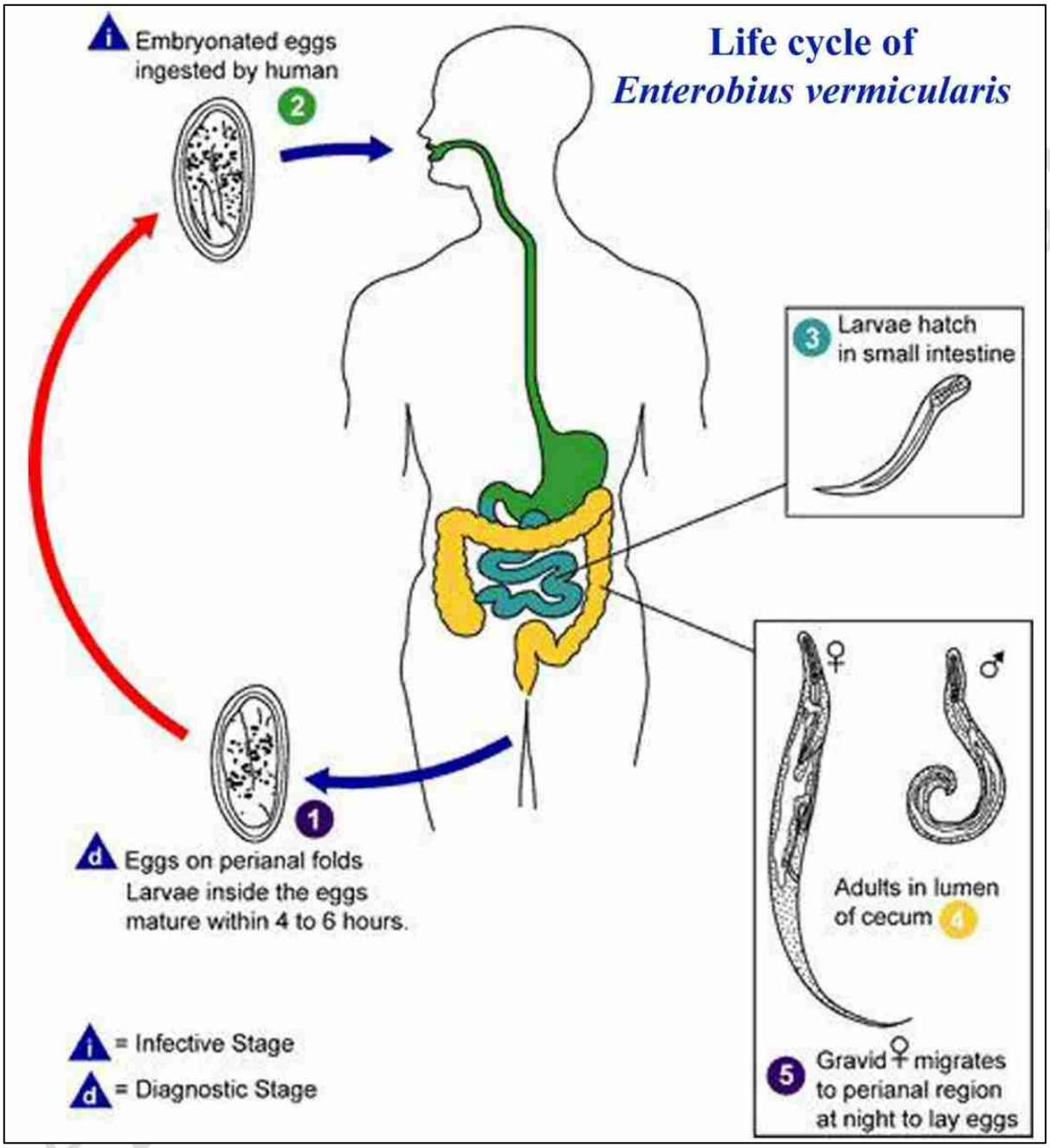


Size range: 48-60 μm long by 20-35 μm wide





- **Life cycle**:


Life cycle of
Enterobius vermicularis
i Embryonated eggs ingested by human
2
3 Larvae hatch in small intestine
Adults in lumen of cecum 4
5 Gravid ♀ migrates to perianal region at night to lay eggs
1
d Eggs on perianal folds
Larvae inside the eggs mature within 4 to 6 hours.
i = Infective Stage
d = Diagnostic Stage

➢ *Ancylostoma duodenale* and *Necator americanus*

- **Common name: Hook-worm.**
- **Scientific Classification**
  - Kingdom: Animal
  - Phylum: Nemathelminth
  - Class: Nematoda
  - Genus: *Ancylostoma* / *Necator*
  - Species: *Ancylostoma duodenale* / *Necator americanus*.

❖ Hookworms are the voracious blood feeders of the nematode world.

❖ *Ancylostoma duodenale* is commonly known as the Old World hookworm.

❖ *Necator americanus* is commonly known as the New World hookworm (american killer).

- **Disease:**
  - Hookworm infection.
- **Distribution**
  - Worldwide.
- **Habitat:**
  - In the small intestine.
- **Mode of infection:**
  - ***Necator*** can only be transmitted through penetration of the skin.
  - ***Ancylostoma*** can be transmitted:
    - Percutaneously.
    - Orally.
- Probably transplacentally.

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- **Definitive host:**
  - Human.
- **Intermediate hosts:**
  - None.
- **Morphology**
  - **Adult:**
    - Small, cylindrical, grayish, white or pink in color.
    - Have buccal capsule with 2 pairs of teeth , 2 lancet and 2 plate.
    - Oesophagus: Club – shaped.
    - The anterior end of the worm is slightly bent dorsally (hence the name hook worm).

	Ancylostoma duodenale	*Necator americanus*
Size of male	10-13 mm.	9-11 mm.
Size of female	8-12 mm.	7-9 mm.
Bucal cavity	2 ventral plates and two large teeth.	Dorsal and ventral cutting plates.
Posterior end	- **The male** has copulatory bursa with two spicules. **The female** has pointed end with short spine.	
Position of vulva	1/3 from posterior	Mid-body
Egg production	25000/ day	9000/ day
Penetration through skin	Yes	Yes
Longevity	5 years	15 years

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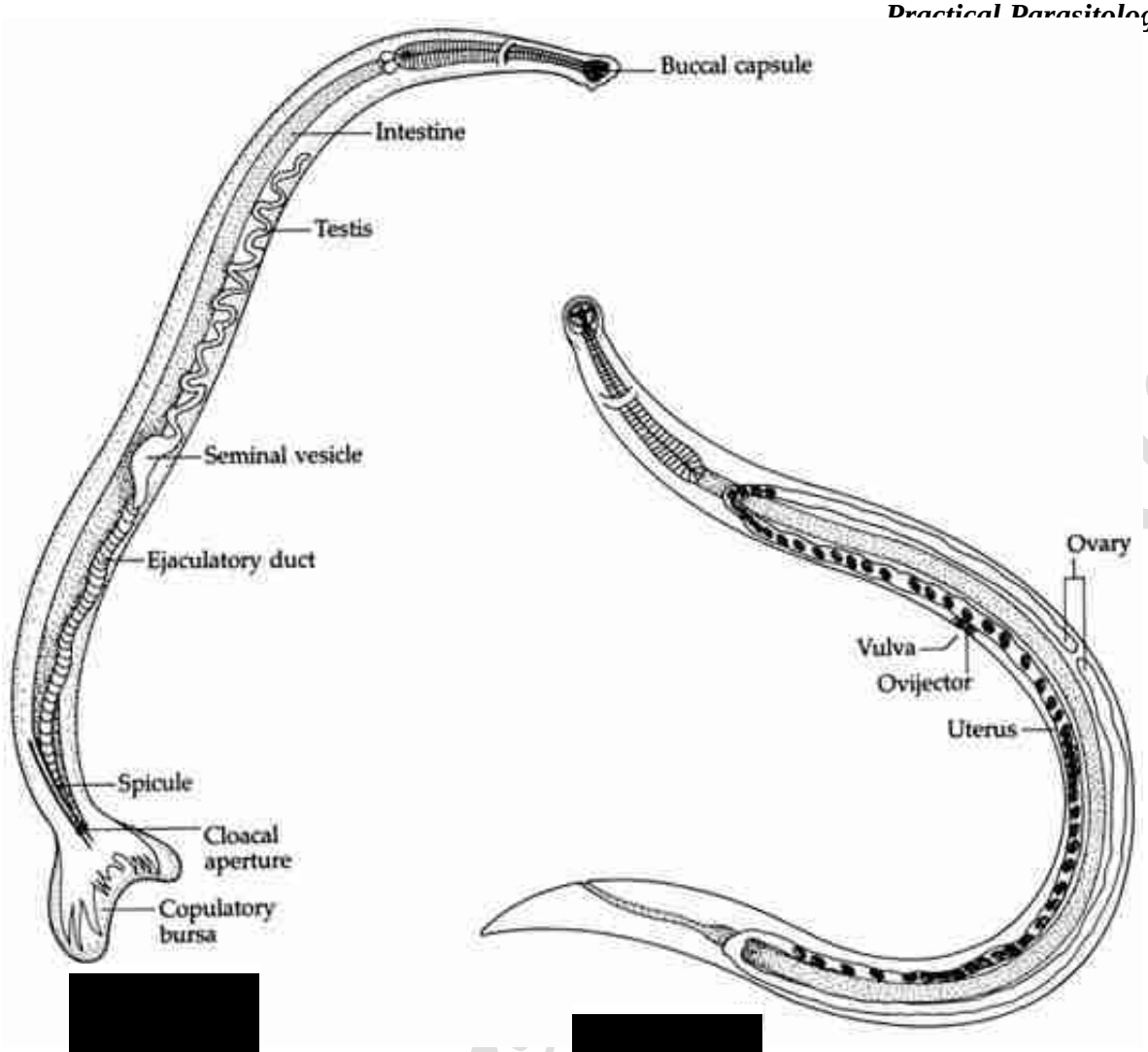

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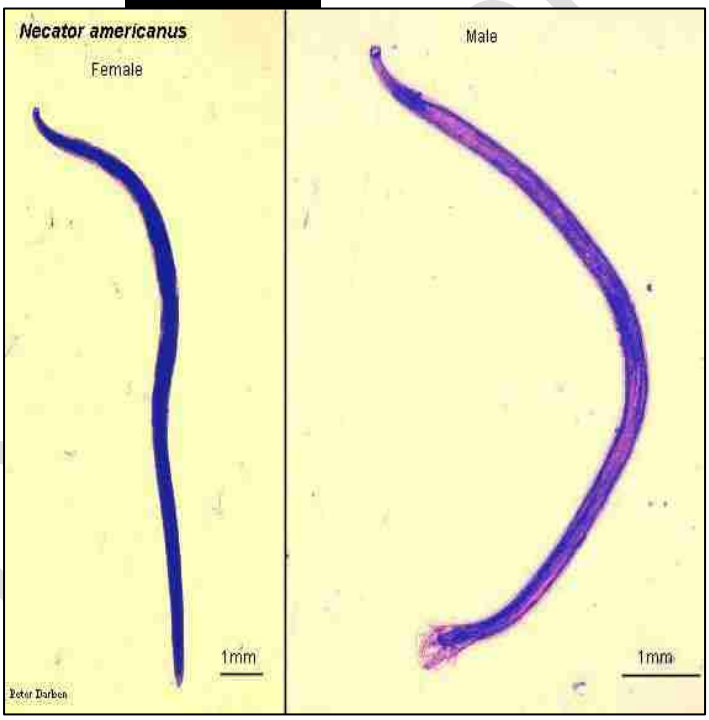
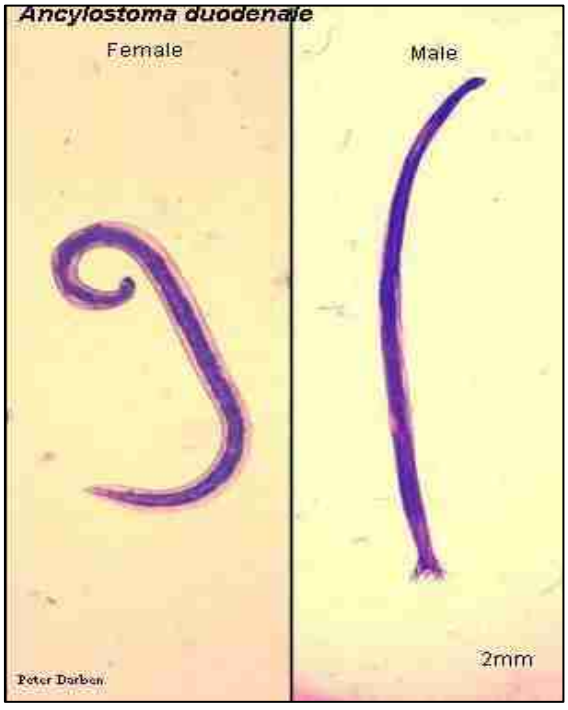
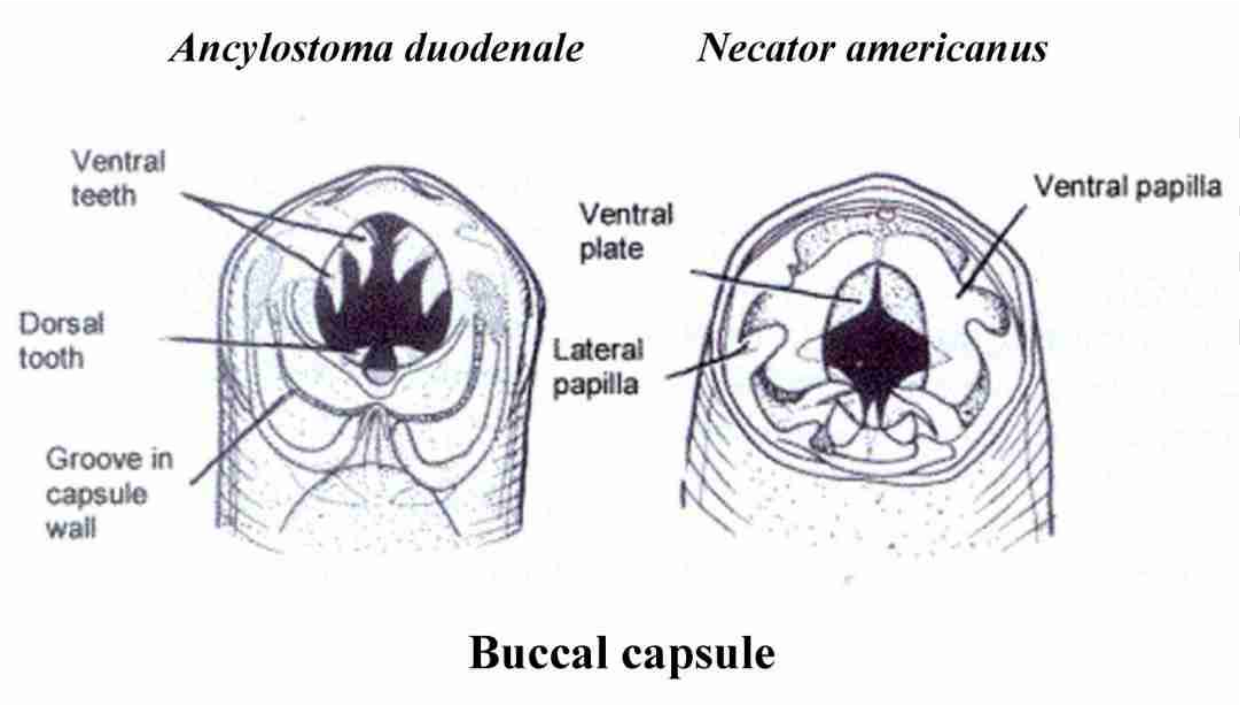




- **Buccal capsle:**

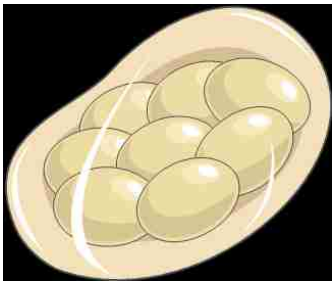


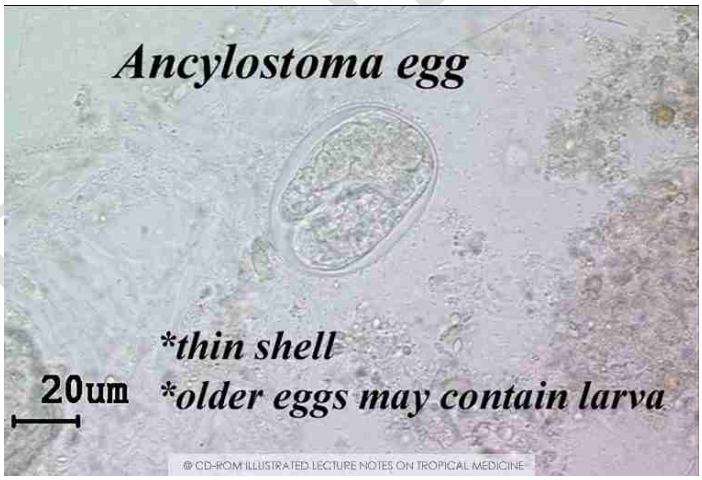
- *Ancylostoma* : contain actual teeth.
- *Necator* : contain pair of cutting plates

- **Copulatory bursa (Posterior end of male):**

➢ **Egg:**

- The eggs of *Ancylostoma* being slightly larger than those of *Necator*.
- Size: 60-75 by 36-40 µm.
- Shape: Oval or can-shaped with blunt poles.
- Shell is smooth, thin and hyaline.
- Color: Colorless (Translucent).
- Content: Immature ovum.
- Embryonic: Content is 2-8cells.





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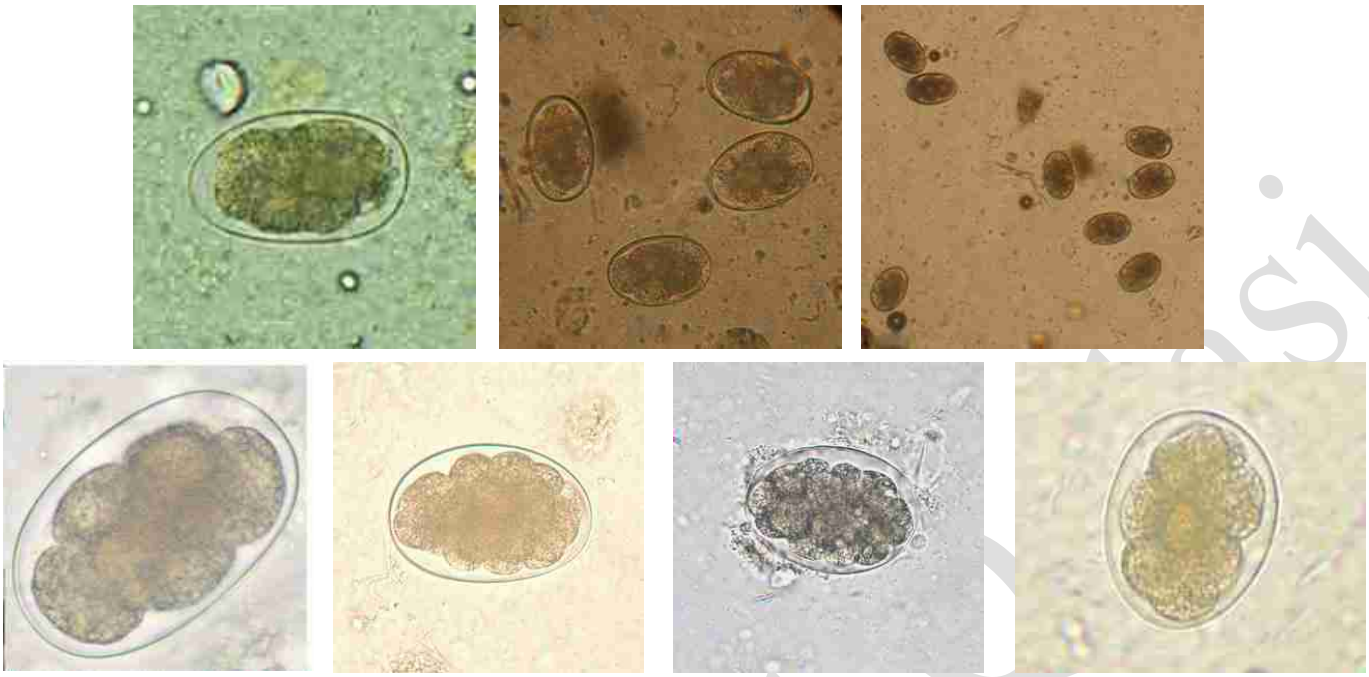


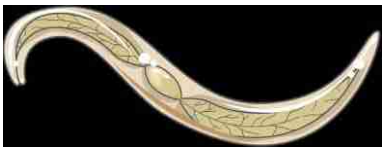
Eggs of hook worm

➢ **Larva**

- There are two types of larva; **Rhabditiform** and **Filariform** larvae.

a. Rhabditiform larvae: Non-infectious

- Size: 270 µm.
- Eggs develop first into noninfectious, and be feeding (rhabditiform) larvae.
- Have short esophagus.
- And small genital primordium.



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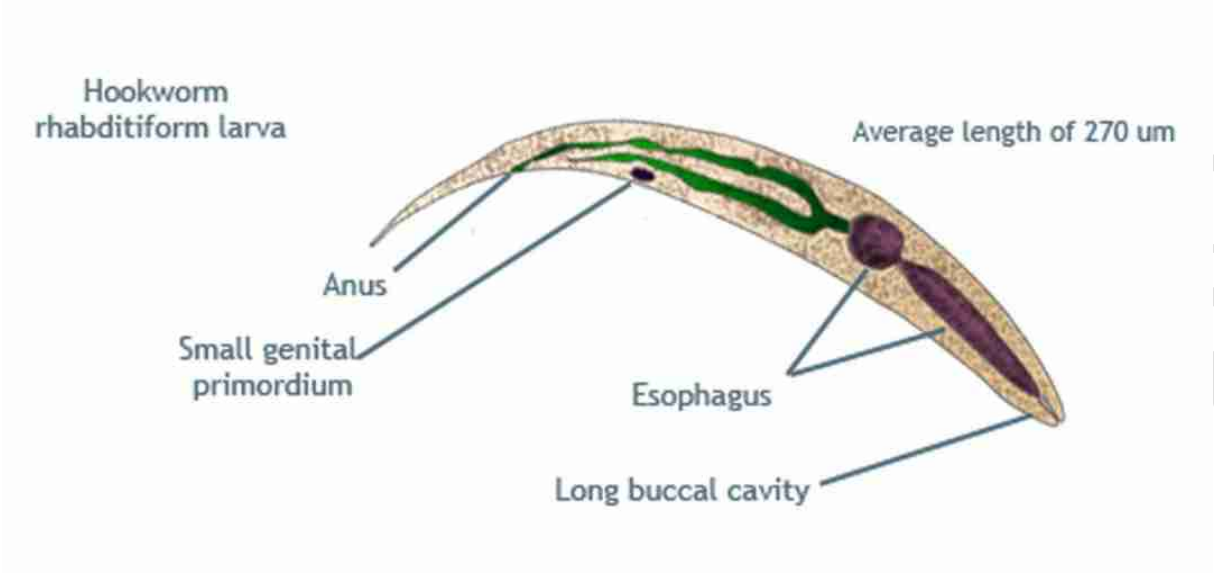

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b. Filariform larvae: Infectious stage

- Develop into third-stage, infectious.
- Have short length of esophagus.
- Have pointed tail.

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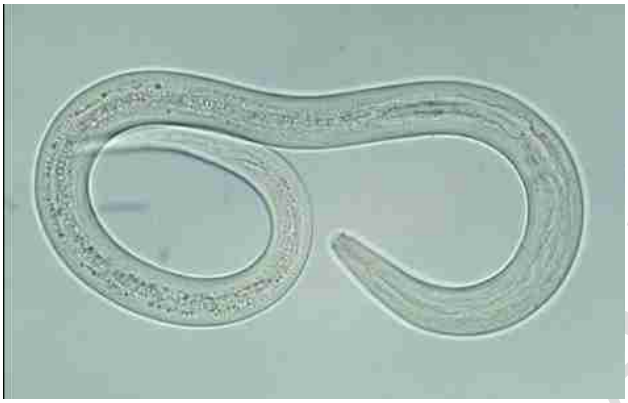

- **Infective stage:**
  - Filariform larvae.
- **Diagnosis**
  - By finding eggs in the feces.

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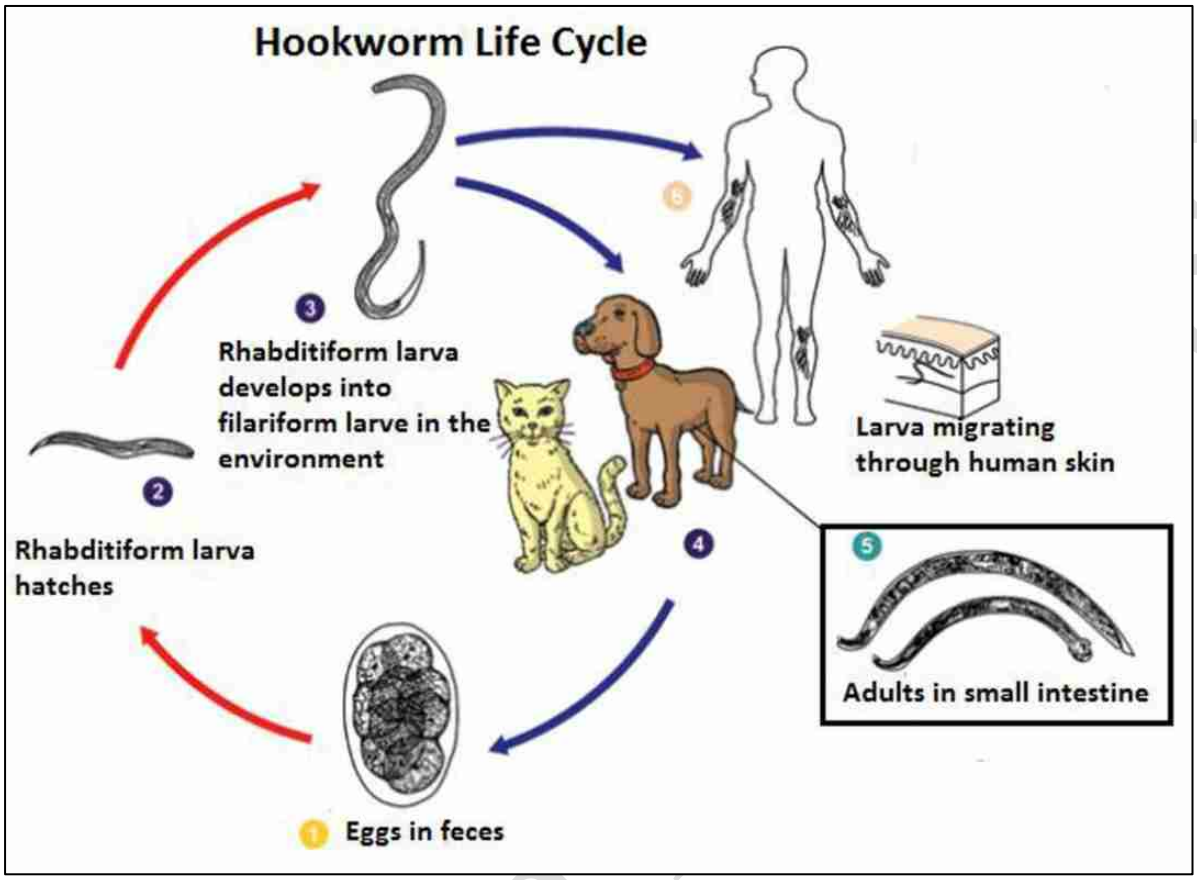
- **Life cycle**:



Good Luck

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